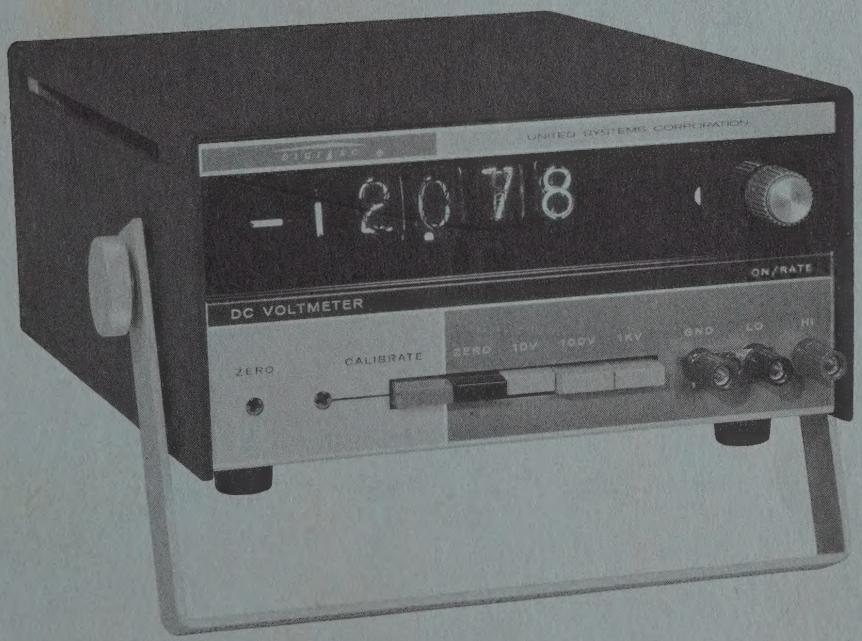
Oct 8, 68

DIGIEC

# DIGITAL MAIN FRAME
# INSTRUCTION MANUAL
## MI-896B

FOR MODELS 251 AND 252




SUPERSEDES MI-869, & 896
S/N 1700 AND UP

UNITED SYSTEMS CORPORATION
918 WOODLEY ROAD/ DAYTON, OHIO 45403 /

MP MASTER
MA26224

DIGIEC® by UNITED SYSTEMS CORPORATION
918 Woodley Road, Dayton, Ohio 45403 ■ (513) 254-6251 ■ TWX (810) 459-1728

# WARRANT and CALIBRATION
# CERTIFICATE

**Main Frame Model** 251

## I. WARRANT

The instrument is warranted to be accurate to 0.05% of reading 1 digit for all ranges if:

Ambient temperature is 60° to 110° F
Power source is 105 to 125 Volts at 50 to 800 Hz
The instrument has been "ON" for at least 20 minutes.
Plug-in is calibrated.

## II. CALIBRATION

**INSTRUMENTATION** – The accuracy and calibration of the 0.01% Certified Standards used in the Laboratory of USC are traceable to the National Bureau of Standards.

**TEST CONDITIONS** – The calibration on this instrument was conducted at an ambient temperature of 25°C ± 3°C with power source of 117 Volts at 60 Hz after 20 minutes of "ON" time.

**DATA**

| POWER SUPPLY ADJUSTMENTS | X | | READING |
|---|---|---|---|
| 18V Supply | 8.45V | 8.33V | 8.45 |
| Ref. Supply (Cal. Pos.) | 9.000V | 2.700V | 9.000 |
| **OPERATION** | | | |
| Rear Input | ok | | |
| Inhibit | ok | | |
| Interrogate | ok | | |
| Knob | ok | | |
| Blanking | ok | | |
| BCD | ok | | |

UNITED SYSTEMS CORPORATION

BY: Joe Moore Jr Inspector

Serial No. 4312

Date 7-16-68

(250)

# TABLE OF CONTENTS


1. GENERAL INFORMATION
1.1 Features Page 3
1.2 Instrument Identification Page 4
1.3 Installation of Main Frame Page 4
1.4 Rack Mounting Page 4
1.5 Plug-in Module Installation and Removal Page 4
1.6 Technical Characteristics Page 5
2. OPERATION
2.1 On/Rate Control Page 6
2.2 Sample Rate Indicator Page 6
2.3 Digital Display Page 6
2.4 Warm-up Period Page 6
2.5 Power Connection and Conversion Page 6
3. CONNECTORS
3.1 Interfacing Connector Page 6
4. PRINCIPLE OF OPERATION
4.1 Power Supplies Page 7
4.2 Control Page 7
4.3 BCD Counters Page 7
4.4 Buffer Storage Page 7
4.5 BCD to Decimal Converter Page 9
4.6 Decimal Display Page 9
5. SERVICE AND TROUBLESHOOTING
5.1 Necessary Service Equipment Page 9
5.2 Fuse Replacement Page 9
5.3 Nixie Tube Replacement Page 9
5.4 Voltage Checks Page 9
5.5 Component Replacement Page 9
5.6 Troubleshooting Hints Page 9
6. CALIBRATION Page 10

## ILLUSTRATIONS AND DIAGRAMS


| | | |
|---|---|---|
| Figure 1. | Rear View of Main Frame | Page 4 |
| Figure 2. | Rack Mounting Panel Adaptor | Page 4 |
| Figure 3. | Front View of Instrument | Page 6 |
| Figure 4. | Block Diagram | Page 8 |
| Figure 5. | 251 Printed Circuit Photograph | Pages 11, 12 |
| Figure 6. | 252 Printed Circuit Photograph | Pages 13, 14, 15 |
| Figure 7. | Interconnecting Wiring Diagram | Page 16 |
| Figure 8. | 251 Parts List | Pages 17, 18 |
| Figure 9. | 251 Schematic | Page 19 |
| Figure 10. | 252 Parts List | Pages 20, 21 |
| Figure 11. | 252 Schematic | Page 22 |
| Figure 12. | Wave Shapes and Voltage Specifications | Page 23 |
| Figure 13. | Voltage and Scope Readings on 251 Power Supply Counter Boards | Page 24, |
| Figure 14. | Voltage and Scope Readings on 252 Power Supply Counter Board | Page 25 |
| Figure 15. | Troubleshooting Flow Chart | Pages 26, 27 |

# DIGITAL MAIN FRAME
# INSTRUCTION MANUAL
## MI-896B

FOR MODELS 251 AND 252

## 1. GENERAL INFORMATION

### 1.1 Features

The Models 251 and 252 Main Frames are precision digital instruments capable of displaying digital information when used in conjunction with plug-in modules.

The Series 250 Main Frame includes all the necessary power supplies and control circuitry for powering and interrogating the plug-in module. The Model 252 Main Frame has four significant digits, whereas the 251 Main Frame has five digits of resolution.

For production use, an auxiliary switch can be used to inhibit the reading. This can be used either to hold a reading or to take readings at a given time. When the switch is closed, the instrument will operate normally. When the switch is open, the digital display will retain the reading of the last sample (unless otherwise specified in the plug-in module instruction manual).

The main frame is normally used with a plug in as a portable instrument, but it can be adapted to a panel mounting by using an optional panel adaptor.

Some of the important features of the Series 250 Main Frames are:

- Long life Nixie Tube display
- Adjustable sampling rate
- Parallel BCD electrical output
- Convenient decimal-point display
- External interrogation
- System ready signal for operating auxiliary equipment
- Temperature compensated, aged, Zener reference for long-term stability
- Plug-in versatility

## 1.2 Instrument Identification

The instrument model, serial number, and other pertinent data are given on the identification tag on the back plate of the instrument. Compatability between the main frame and the interchangeable "plug-in" modules is expressed by the first three digits of the model number. For example, the Model 252 Main Frame will accept the Model 252-1 plug-in digital voltmeter. (See Figure 1).

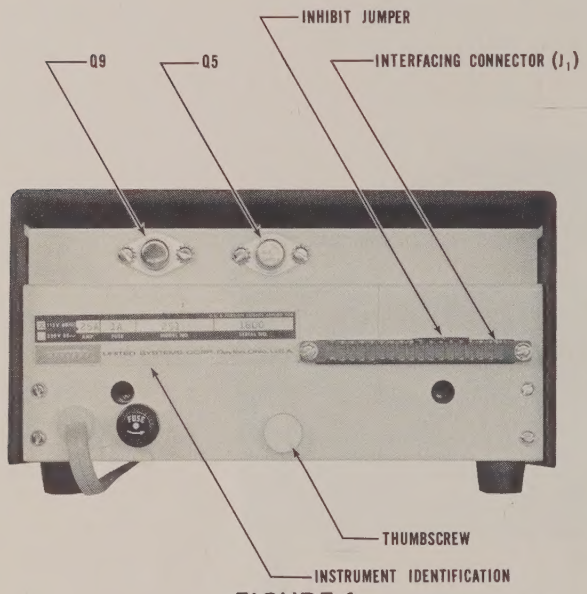



FIGURE 1

## 1.3 Installation of Main Frame

Install instrument in any convenient location where a source of line power (Section 1.6) is available. In permanent installations, allow sufficient space around the instrument to permit adequate cooling. In all installations, enough air convection must be provided to limit the ambient temperature around the instrument to the maximum operating temperature. A 36-pin interfacing connector (Cinch P/N 251-18-30-160-E) is included with each instrument (Section 3.1). Install this connector at the back of the instrument as shown in Figure 1. CAUTION: If this connector is not installed, the instrument will be inoperative.

## 1.4 Rack Mounting

Models 251 and 252 Main Frames can be rack mounted into a 5.25 x 19 inch rack by using the Model 720 Panel Adaptor Kit. For installation of the panel adaptor, see Assembly Instructions (M1-813A) which are packed with the Panel Adaptor (See Figure 2).

## 1.5 Plug-In Module Installation and Removal

The plug-in module is locked in place by means of a retaining thumbscrew as shown in Figure 1. Proper instrument alignment is assured by a set of "rails" on the main frame and a set of mating slotted guides on the plug-in module.

To install the plug-in module, elevate the front of the main frame approximately three inches and slide the plug-in module into the main frame by carefully engaging the slotted guides with the rails on the main frame. By engaging and tightening the thumbscrew, draw the plug-in module firmly into place thereby assuring proper contact of the edge connector. Power must be turned off in order to remove or insert the plug-in module. Do not operate the main frame without the plug-in module.

To remove the plug-in module, loosen the thumbscrew completely and push it firmly in to disengage the edge connector. Then pull out the plug-in module like a drawer.

FIGURE 2

## 1.6 Technical Characteristics

**Readout:** Ultra long life nixie tubes – 4 digits

**Sampling rate:** Adjustable 10/sec to one/2 second

| | 251 | 252 |
|---|---|---|
| Encoding interval: | 75msec max. | 35msec max. |
| Maximum reading: | 13999 digits | 2999 digits |

**Digital output:**

A. Available from buffer storage 4 column 1-2-4-8 BCD code.

B. Digital output level:

Logic 0 +0.4V max.
Current sink: 5ma max.

Logic 1 +2.3V minimum
Output impedance = 3.6K

C. Range or decimal point location (2 bit code)

| 251 | Logic | 252 |
|---|---|---|
| 9.999 | 00 | 2.000 |
| 99.99 | 01 | 20.00 |
| 999.9 | 10 | 200.0 |
| – | 11 | 1000. |

D. Polarity signal (single bit)

| Logic | Sign |
|---|---|
| 0 | + |
| 1 | - |

E. Blanking (single bit)

| Logic | Condition |
|---|---|
| 0 | Unblanked |
| 1 | Blanked |

**Overrange bit:** Series 251 Main Frames have an overrange neon light which appears as a one in the fifth digit. To indicate overrange to a printer or other external equipment, an overrange bit is provided.

| Logic | Condition |
|---|---|
| 0 | Overrange lamp OFF |
| 1 | Overrange lamp ON |

**Serial digit output (Section 3.1):** Pulse train IV peak-peak square wave @ 625KHz unit code. Maximum load 2.2K ohms.

**Interrogation requirements:** External switch closure, or externally furnished positive going pulse of 6 to 24 Volts (into a 10K load) and a rise time of 2 $\mu$s/volt or less.

| | 251 | 252 |
|---|---|---|
| Maximum Interrogation rate: | 10 samples/sec | 20 samples/sec. |

**System ready signal:** 40 $\mu$s. 3 volt (2ma. max.) Positive going pulse. Output impedance = 1K

**Interfacing:** BCD data output, Interrogation control, and rear input with mating connector furnished.

**Mounting Position:** Any

**Ambient temperature:** $60^{o}$ to $110^{o}$F

**Power requirements:** 105-125 standard, 50/800Hz. 10VA (optional 210/250V "S" suffix).

**Fuse:** Fused at 1 amp on standard model
Fused at 1/2 amp on "S" suffix model

**Isolation:** 500V to case and power line ground

**Dimensions:** Height 4-1/2", Width 8-5/8", Depth 11-1/2"

**Net weight:** Approximately 11 lbs. including plug-in module.

**Shipping weight:** Approximately 15 lbs.

## 2. OPERATION

### 2.1 On/Rate Control

When the rate control is in the fully counterclockwise position, power is disconnected from the instrument.

In the fully clockwise position, power is ON and the sampling rate is at its maximum of about 10 samples per second. As the rate control is turned further counterclockwise, sampling will cease completely. (See Figure 3). This position, which is just prior to switching the instrument off, is used to store a given reading, even if the input parameter is changing. (This position is also used for sampling on command by using external interrogation (See Section 3.1).

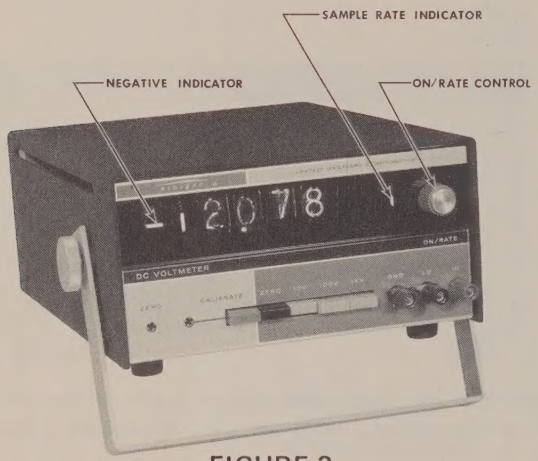



FIGURE 3

### 2.2 Sampling Rate Indicator

This indicator, which is located adjacent to the On/Rate Control, is used to indicate the rate of sampling (Figure 3).

### 2.3 Digital Display

The instrument readout consists of gas ionization readout tubes. The parameter under measurement will appear in convenient decimal form complete with decimal points and polarity information.

All readings are assumed to be positive unless a negative sign to the left of the readout indicates a negative reading. The decimal display capacity is to four significant digits. In the case of Model 251, readings above 9999 are presented as five significant digits (Figure 3).

If the maximum digital readout capacity is exceeded, the entire readout will be blanked out except the sampling indicator which will continue to indicate that the instrument is turned on and sampling.

### 2.4 Warm-up Period

Turn On/Rate Control to the fully clockwise (maximum sampling) position for 20 minutes. Also observe warm-up requirements of the particular plug-in module in use by referring to the appropriate instruction manual.

### 2.5 Power Connection and Conversion

This instrument is supplied for operation on 115V or 230V as indicated on the rear panel label. If conversion from 115V to 230V line is desired, remove the instrument case and proceed as follows: (See Figure 5, View 2 or Figure 6, View 2).

1. Remove Jumper 1 and 2.
2. Connect a jumper between holes A and B.
3. Connect a jumper from J1-E to J1-F

## 3. CONNECTORS

### 3.1 Interfacing Connector

This connector provides a convenient method for interfacing the instrument for use with other instruments in systems applications. Various functions are available as shown in the following table. Before soldering leads to connector pins, remove connector from instrument. (Figure 1).

| PIN | 251 FUNCTION | 252 |
|---|---|---|
| 1 | Input high | Input high |
| 2 | Earth ground | Earth ground |
| 3 | Input low | Input low |
| 4 | 00040 | 0040 |
| 5 | Not connected | Not connected |
| 6 | Not connected | Not connected |
| 7 | Not connected | Not connected |
| 8 | 00080 | 0080 |
| 9 | Inhibit | Inhibit |
| 10 | Serial output | Serial output |
| 11 | Ground | Ground |
| 12 | External interrogation pulse | External interrogation pulse |
| 13 | System ready pulse | System ready pulse |
| 14 | Pulse source | Pulse source |
| 15 | Inhibit | Inhibit |
| 16 | 10000 | Not connected |
| 17 | Polarity bit | Polarity bit |
| 18 | Blanking bit | Blanking bit |
| A | 00004 | 0004 |
| B | 00008 | 0008 |
| C | 00001 | 0001 |
| D | 00002 | 0002 |
| E | Not connected | Not connected |
| F | Not connected | Not connected |
| H | 00010 | 0010 |
| J | 00020 | 0020 |
| K | 00400 | 0400 |
| L | 00800 | 0800 |

| | | |
|---|---|---|
| M | 00100 | 0100 |
| N | 00200 | 0200 |
| P | 04000 | Not Connected |
| R | 08000 | Not Connected |
| S | 01000 | 1000 |
| T | 02000 | 2000 |
| U | Decimal logic (most significant digit) | Decimal logic (most significant digit) |
| V | Decimal logic (least significant digit) | Decimal logic (least significant digit) |

**Inhibit Pins**

Connect a jumper between 9 and 15 for normal sampling. Open circuit inhibits sampling unless otherwise specified in the plug-in module instruction manual (jumper plug provided). (See Figure 1).

**External Interrogation Pulse**

The pulse required must be positive going with an amplitude of 6 to 24 volts (into a 10K load) with a rise time of 2 microseconds/volt or less.

**Pulse Source**

This consists of a charged capacitor and is used for external triggering of the sampling generator. To use this source, turn the on/gate control to the counter-clockwise position, just prior to the instrument off. A momentary switch closure may then be used between Pins 12 and 14.

**System Ready Pulse**

This consists of a pulse indicating the end of the encoding time and the entry of new data into the BCD storage. This pulse is positive going with an amplitude of 3 volts and a width of 40 $\mu$s (See Figure 4).

**Serial Digit Output**

The serial output consists of a train of pulses, the number of which corresponds to the displayed digital values of the readout. The train of pulses always occurs during the "encode" interval. The serial output is useful in telemetry and other applications where the instrument readout is to be transmitted to a remote location by means of a single line. The serial output pulse train is a 1 volt peak-peak square wave @ 625KHz unit code. The maximum load is 2.2K ohms (Section 3.1). With some of the plug-in modules, the BCD counters are allowed to run continuously, thus the serial output does not apply to these instruments. (See the specific plug-in module instruction manual for details).

## 4. PRINCIPLE OF OPERATION

The Main Frame is essentially a serial to parallel converter with electrical (BCD) and visual (decimal) readout. Serial to parallel conversion is accomplished by counting pulses from the plug-in module, then storing and displaying a totalized count in accordance with the internal control commands of the instrument.

The main frame contains the following elements:

A. Regulated and unregulated power supplies
B. Control circuit
C. BCD counters
D. Buffer storage
E. BCD to decimal converters and decimal drivers
F. Decimal display.

### 4.1 Power Supplies

The two unregulated supplies, +200V and +3.6V, provide operating voltages for the display and the integrated circuits respectively. The two regulated supplies, +17.7V and -13V, are referenced to a precision temperature compensated zener, and are employed to power all critical circuits, both in the main frame and the plug-in module. The 9.4 volt reference zener also provides suitable calibrating voltages for calibration of the plug-in module.

### 4.2 Control

The control circuit coordinates the operation of the entire main frame. A typical operating sequence is initiated by the sampling generator, or by an external command (See Figure 4), which emits a pulse to trigger a monostable multivibrator. The multivibrator establishes the encode gate, during which the plug-in module must complete an analog to digital conversion. (Coincident with the leading edge of the "encode gate", a reset pulse is generated which resets all BCD counters to zero.) During the encoding interval, a train of pulses from the plug-in module are counted by the BCD counter. Coincident with the trailing edge of the "encode gate", a "read" pulse is generated and is used to transfer the BCD information from the BCD counters to the storage registers.

Some plug-in modules do not require an "encode gate" and the BCD counters are allowed to run continuously. In this case, the "read" pulse is controlled directly by the plug-in module. To operate this type of plug-in, the sampling generator must be inhibited (see the appropriate plug-in module manual).

### 4.3 BCD Counters

The BCD counters consist of integrated circuit dual inline packages which contain 4 RTL flip flops with suitable gating for producing a 1248 code per decade. In some cases where an incomplete decade exists, individual integrated circuit flip flops are used.

### 4.4 Buffer Storage

The buffer storage consists of integrated circuit dual inline packages, one package for each decade. Each

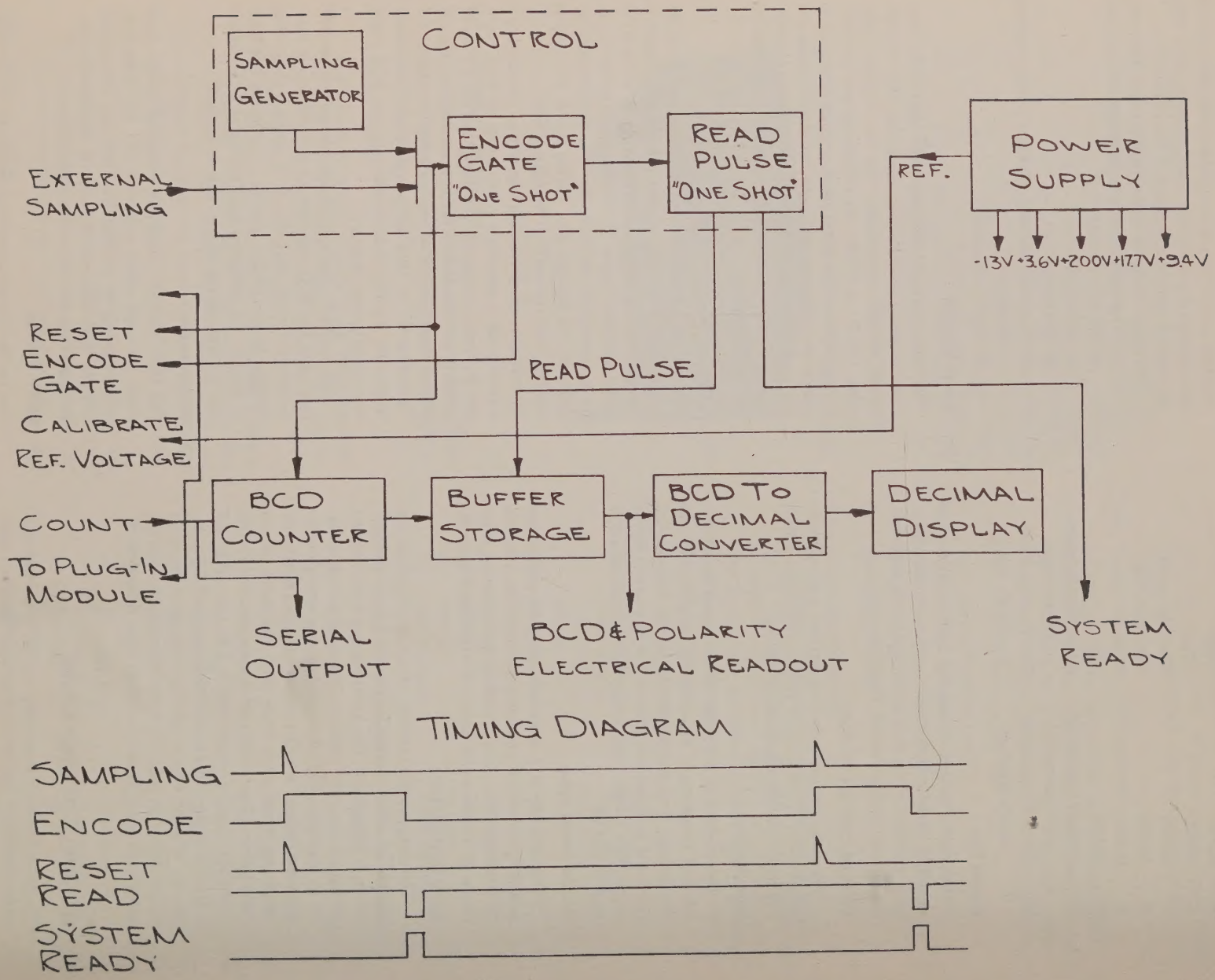

CONTROL
SAMPLING GENERATOR
ENCODE GATE "ONE SHOT"
READ PULSE "ONE SHOT"
EXTERNAL SAMPLING
POWER SUPPLY
REF.
-13V +3.6V +200V +17.7V +9.4V
RESET ENCODE GATE
READ PULSE
CALIBRATE REF. VOLTAGE
COUNT
TO PLUG-IN MODULE
BCD COUNTER
BUFFER STORAGE
BCD TO DECIMAL CONVERTER
DECIMAL DISPLAY
SERIAL OUTPUT
BCD & POLARITY ELECTRICAL READOUT
SYSTEM READY
TIMING DIAGRAM
SAMPLING
ENCODE
RESET READ
SYSTEM READY

FIGURE 4

register contains 4 flip flops for storing the 4 bits of information from each of the BCD decade counters. The storage function for incomplete decades is performed by individual integrated flip flops. The storage register also contains built-in buffer stages for driving the BCD output lines.

### 4.5 BCD to Decimal Converter

The BCD to decimal conversion is accomplished by a set of integrated decoder-drivers which accept BCD information from the buffer storage and convert it into suitable codes and levels to drive the decimal display directly.

### 4.6 Decimal Display

The instrument display consists of 4 "nixie" type indicator tubes and additional indicators for displaying negative polarity, overrange, and sampling rate. All readings are positive unless a negative sign indicates a negative polarity. A blanking feature extinguishes the display if the number in the storage register is greater than 13999 digits on Model 251 or 2999 digits on Model 252.

## 5. SERVICE AND TROUBLESHOOTING

### 5.1 Necessary Service Equipment

1. A standard VTVM of 3% accuracy or better,
2. An oscilloscope capable of measuring 500KC or better,
3. A precision voltmeter with .02% accuracy or better (such as a Keithley Differential Voltmeter, Model 660).

If service equipment of the required accuracy is not available, the instrument may be returned to United Systems Corporation for repair

### 5.2 Fuse Replacement

For 115V, use a 1 amp, AGC fuse. For 230V, use a 1/2 amp, AGC fuse. Determine the cause of fuse failure before operating the instrument again.

### 5.3 Nixie Tube Replacement

All four "nixie" tubes are not the same. Two of the "nixie" tubes contain decimal points, the other two do not. Even though the tubes are different, both types can be replaced with a decimal indicating "nixie" tube.

Burrough Part No. B5441
USC Part No. 49-6921-2.

### 5.4 Voltage Check

When an operating fault occurs, it is often useful to determine if voltages measured in the circuit are normal.

Using a general purpose VTVM, check AC and DC voltages at the points noted on the schematic (Figures 9 and 11). When checking the reference calibration voltage, a high impedance voltmeter with .02% accuracy or better must be used (Section 5.1).

Pay particular attention to those which are more than ±15% away from the schematic values and attempt to isolate one section of the instrument as being faulty. Ultimate determination of the fault may require removal and testing of a transistor or component.

### 5.5 Component Replacement

All components can be replaced with standard units except Z2 which is factory selected.

### 5.6 Troubleshooting Hints

**Counter Section**

Each section depends on correct operation of previous sections; i.e., if the units digit is damaged, the "tens" and "hundreds" digit will not give correct displays. However, if the "tens" digit is the damaged section, the "units" section will operate normally but the "hundreds" digit will not display correct readings. Beginning with "units" first, then "tens", etc., this method may be used to determine faulty section.

**Power Supply Section**

Due to interdependence, the 9.4 volt Zener must be operating before proper operation can be expected from the other supplies. Therefore, correct this supply before attempting to repair the other supplies.

The +200 volt supply depends on the +17.7 volt and the -13 volt supply in order to operate properly. Therefore, the +17.7 and -13 supplies should be checked before attempting to repair the +200 volt supply.

**Control Section**

The Control Section produces the timing required to transfer data for one location to another within the instrument. To troubleshoot this section the following procedure may be used.

A. Set sample rate to store (see Section 2.1) and check the logic levels out of the counters and BCD outputs. Output logic is false at the counters and true at the BCD outputs.
B. Keep sample rate on store and check BCD level at the buffer storage. Output at these points is false.
C. Set sample rate to maximum. Check encode gate width and amplitude (See Figure 12).
D. Check read pulse.
E. Check reset pulse.
F. Set the sample rate back to store and check the digital output from the BCD to decimal converter.

## TROUBLESHOOTING HINTS (Cont.)

| SYMPTOMS | POSSIBLE CAUSE | SECTIONS |
|---|---|---|
| Number in a nixie tube stays on at all times. | Defective nixie tube, defective BCD to decimal converter. Defective buffer storage or BCD counter. | 5.3, 4.4, 4.5 |
| Two or more numbers come on together in nixie tube. | Defective BCD to decimal converter. | 4.5 |
| Digital display decade does not change with input change. | Defective BCD counter. Check serial output and system ready pulse. | 4.2, 4.3, Fig. 12 |
| Will not sample automatically but will sample when externally interrogated. | Defective unijunction transistor (Q1). Open On/Rate Control, interfacing connector not wired for automatic sampling. | 1.3, 3.1, Fig. 9 & 11 |
| Instrument samples OK, but sample indicator does not light. | Defective neon (L1), defective neon driving transistor (Q4). | Fig. 9 & 11 |
| All nixies read Zero. | Loss of read pulse, plug-in module not plugged in all the way, defective plug-in module, defective IC16. | 1.5, 4.2 |
| Overrange light comes on at random. | Leaky decimal driving transistors, defective neon. | Fig. 9 & 11 |
| Numbers change at random. | Reset pulse, defective counter. | 4.2, 4.3, Fig. 12 |
| Will not blank. | Defective high voltage power supply. Check Q12 & 13. | Fig. 9 & 11 |
| Rate lamp does not go off. | Leaky rate lamp driver (Q4). | Fig. 9 & 11 |

## 6. CALIBRATION

To calibrate the instrument, insert a plug-in module. Note that there are two trimmer potentiometers on the main frame board. The trimmers adjust (1) +17.7V for Zener current adjustment and (2) calibration voltage (see Section 5.1, and Figure 5 or 6).

1. **Zener Current Adjust**
   The Zener diode is designed to be temperature compensated when 10 milliamps are flowing through the Zener. To perform this adjustment, the difference between two voltages must be measured. Therefore, be certain that neither of the voltmeter leads are grounded. To adjust this current, use the following procedure:
   Connect the positive lead of the VTVM to TP7 and the negative lead to TP8. Adjust the +17.7 volt trimmer (R29) for 8.45 volts on Model 251 and 8.33 volts on Model 252.
2. **Calibration Voltage**
   Set the positive lead of the differential voltmeter to the calibration voltage out (TP9), and the negative lead of the voltmeter to the positive end of C10. Adjust R35 for 9.000 volts on Model 251 and 2.700 volts on Model 252.

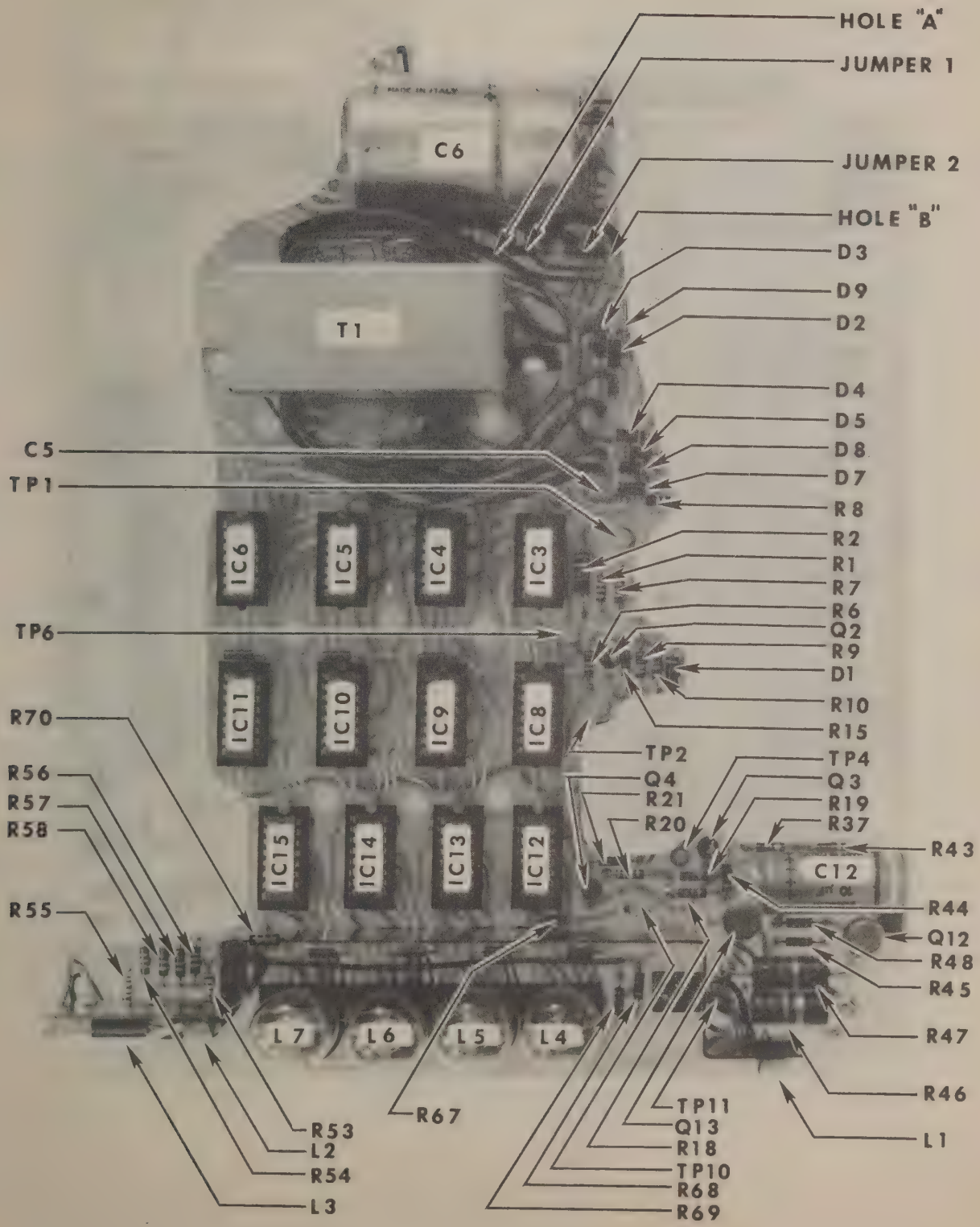



FIGURE 5 (VIEW 1)

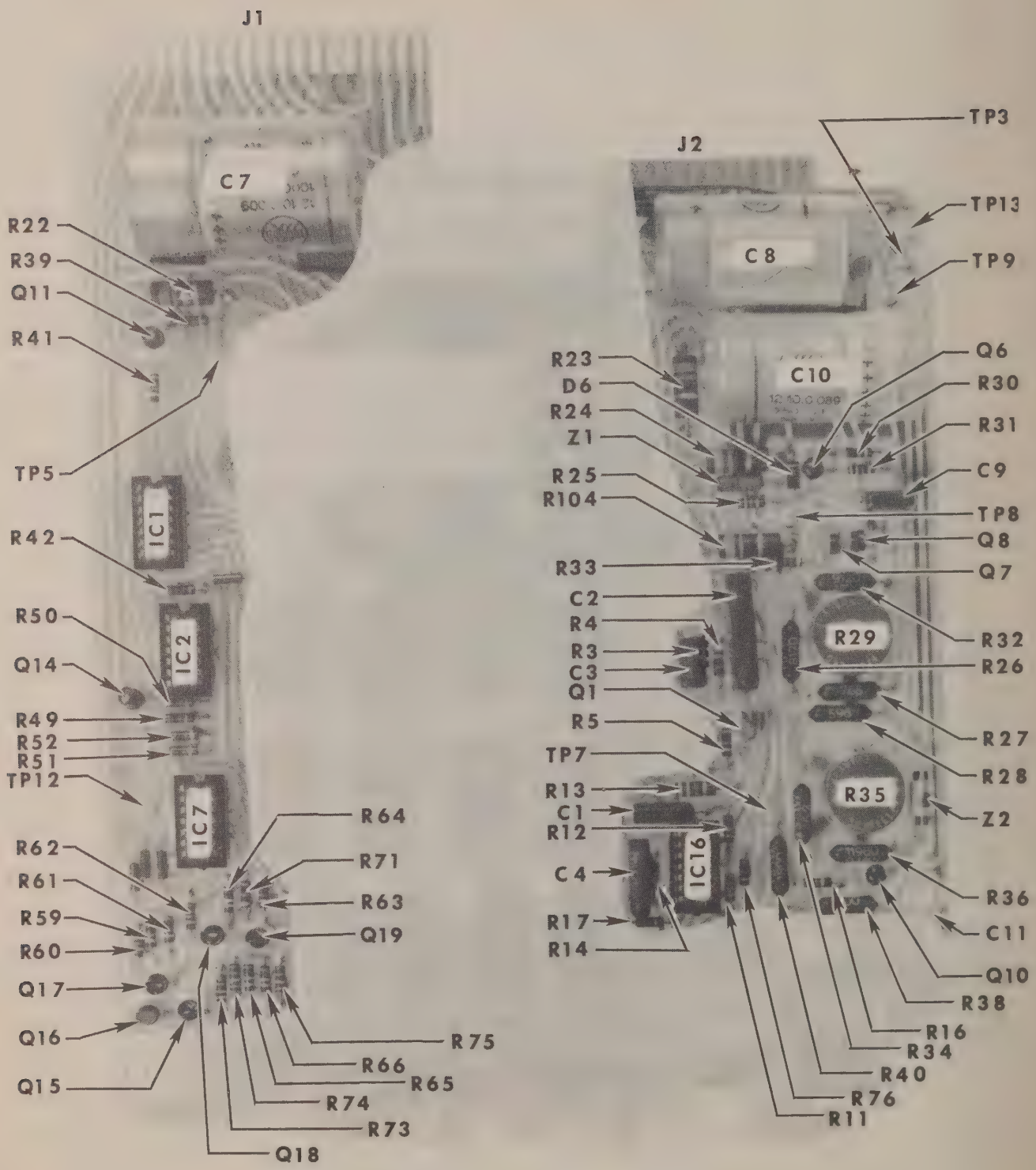



FIGURE 5 (VIEW 2)

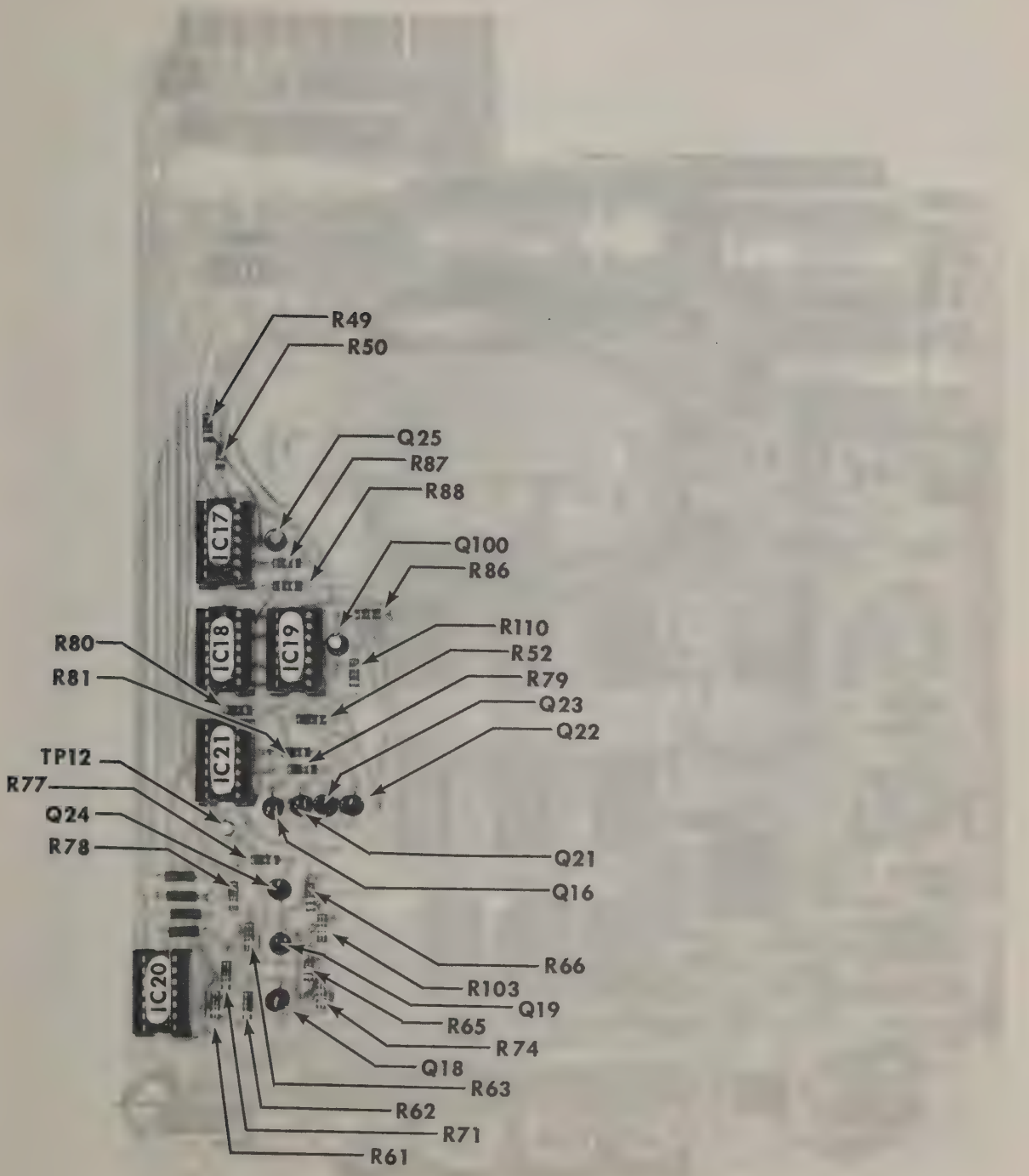



FIGURE 6 (VIEW 1)

252 PRINTED CIRCUIT PHOTOGRAPH

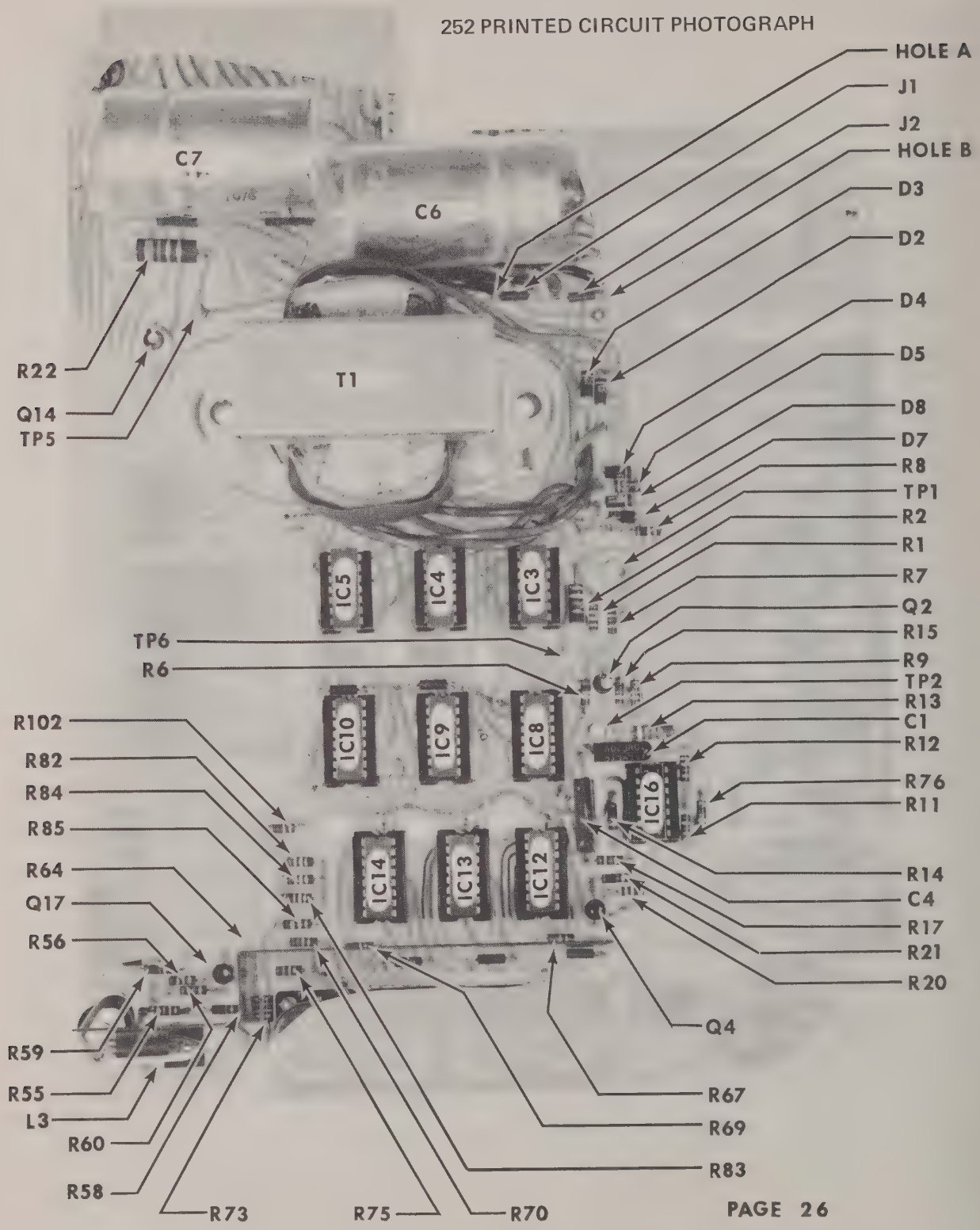



FIGURE 6 (VIEW 2)

## 252 PRINTED CIRCUIT PHOTOGRAPH

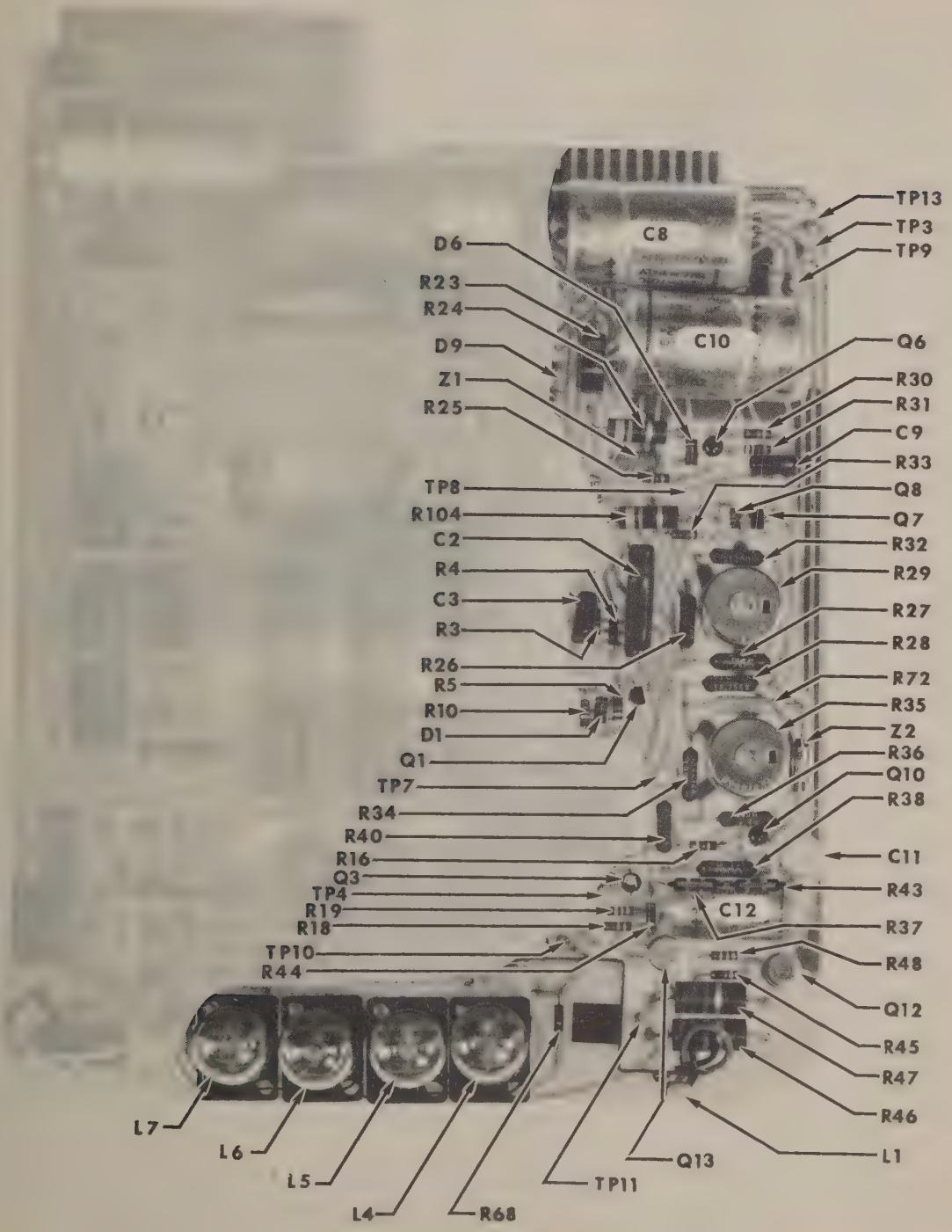



FIGURE 6 (VIEW 3)

## INTERCONNECTING WIRING DIAGRAM

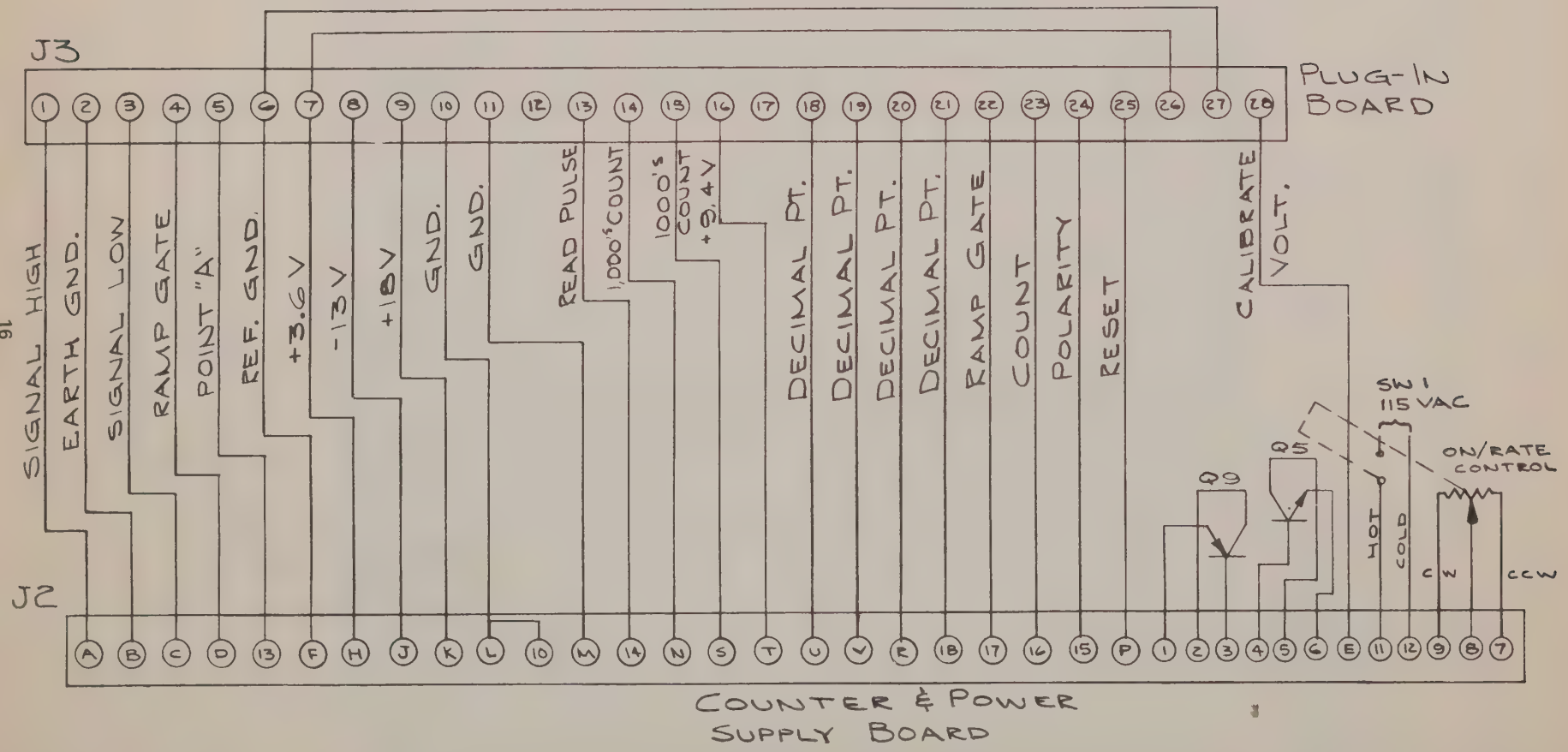



FIGURE 7

## PARTS LIST FOR POWER COUNTER BOARD
## MODEL 251

| SYMBOL | DESCRIPTION | STOCK NUMBER |
|---|---|---|
| R1, 48 | 27K, 10%, 1/4W, Carbon Resistor | 55-10101J27K |
| R2 | 390 Ohm, 10%, 1/2W, Carbon Resistor | 55-10102J390 |
| R3, 18, 57, 58 | 56K, 10%, 1/4W, Carbon Resistor | 55-10101J56K |
| R4 | 3.9Meg, 10%, 1/4W, Carbon Resistor | 55-10101J3R9M 1R8 |
| R5, 14, 44 | 100 Ohm, 10%, 1/4W, Carbon Resistor | 55-10101J100 |
| R6, 9, 12 | 10K, 10%, 1/4W, Carbon Resistor | 55-10101J10K |
| R7, 16, 17, 25 | 2.7K, 10%, 1/4W, Carbon Resistor | 55-10101J2R7K |
| R8 | 100K, 10%, 1/4W, Carbon Resistor | 55-10101J100K |
| R10 | 12K, 10%, 1/4W, Carbon Resistor | 55-10101J12K |
| R11 | 270 Ohm, 10%, 1/4W, Carbon Resistor | 55-10101J270 |
| R13 | 470 Ohm, 10%, 1/2W, Carbon Resistor | 55-10102J470 |
| R15, 21, 30, 39, 41, 45, 49, 50, 51, 52, 61, 71, 76, 59 | 1K, 10%, 1/4W, Carbon Resistor | 55-10101J1K |
| R19, 54, 56 | 68K, 10%, 1/4W, Carbon Resistor | 55-10101J68K |
| R20, 53, 55 | 470K, 10%, 1/4W, Carbon Resistor | 55-10101J470K |
| R22 | 0.56 Ohm, 10%, 1W, Wire Wound Resistor | 55-10124JR56 |
| R23 | 15 Ohm, 10%, 1W, Wire Wound Resistor | 55-10124J15 |
| R24, 104 | 33 Ohm, 10%, 1W, Wire Wound Resistor | 55-10124J33 |
| R26 | 8170 Ohm, 1%, 1W, Wire Wound Resistor | 55-10121ED8170 |
| R27 | 765 Ohm, 1%, 1W, Wire Wound Resistor | 55-10121ED765 |
| R28 | 596 Ohm, 0.5%, 1W, Wire Wound Resistor | 55-10121DD596 |
| R29 | 500, 20%, 2W, Trimmer BE36124 | 55-10152K500 |
| R31 | 4.7K, 10%, 1/4W, Carbon Resistor | 55-10101J4R7K |
| R32 | 9120 Ohm, 1%, 1W, Wire Wound Resistor | 55-10121ED9120 |
| R33 | 2.2K, 10%, 1/4W, Carbon Resistor | 55-10101J2R2K |
| R34 | 46.2 Ohm, 1%, 1W, Wire Wound Resistor | 55-10121ED46R2 |
| R35 | 300 Ohm, 20%, 2W, Trimmer BE36123 | 55-10152K300 |
| R36 | 11.98K, 0.1%, 1W, Wire Wound Resistor | 55-10121BD11R98K |
| R37, 43 | 5.6K, 10%, 1/4W, Carbon Resistor | 55-10101J5R6K |
| R38 | 1200 Ohm, 1%, 1W, Wire Wound Resistor | 55-10121ED1200 |
| R40 | 1800 Ohm, 1%, 1W, Wire Wound Resistor | 55-10121ED1800 |
| R42 | 15K, 10%, 1/4W, Carbon Resistor | 55-10101J15K |
| R46 | 22K, 10%, 2W, Carbon Resistor | 55-10104J22K |
| R47 | 5.6k, 10%, 2W, Carbon Resistor | 55-10104J5R6K |
| R60, 62, 63 | 1.5K, 10%, 1/4W, Carbon Resistor | 55-10101J1R5K |
| R64, 65, 66 | 150K, 10%, 1/4W, Carbon Resistor | 55-10101J150K |
| R67, 68, 69, 70 | 18K, 10%, 1/4W, Carbon Resistor | 55-10101J18K |
| R72 | Factory Selected | |
| R73, 74, 75 | 180K, 10%, 1/4W, Carbon Resistor | 55-10101J180K |
| L1, 2, 3 | Lamp Neon A261 | 52-7654 |
| L4, 6 | Nixie Tube B5441 | 49-6921-2 |
| L5, 7 | Nixie Tube B5440 | 49-6921-1 |

FIGURE 8

## PARTS LIST FOR POWER COUNTER BOARD MODEL 251 (Cont.)

| SYMBOL | DESCRIPTION | STOCK NUMBER |
|---|---|---|
| Power Supply & Counter Circuit Board | | 54-7279A |
| Mother Board | | 54-7280 |
| SW-1 | On-Off Switch and Rate Control | GC45-4 |
| IC1 | Dual J-K Flip-Flop MC790P | 40-7485 |
| IC2 | JK Flip-Flop, Inverter, Buffer MC787P | 40-7486 |
| IC3, 4, 5, 6 | Counter 958 | 40-7516 |
| IC7, 16 | Quad and Gate MC724P | 40-7483 |
| IC8, 9, 10, 11 | Buffer Storage 959 | 40-7514 |
| IC12, 13, 14, 15 | Decoder 960 | 40-7510 |
| Q1 | 2N2646 Unijunction transistor | 40-7794 |
| Q2, 3, 11, 14 | 2N2924 Transistor, Signal | 40-4233-4 |
| Q4, 15, 16, 17 18, 19 | 2N3877 Transistor, Signal | 40-2N3877 |
| Q5 | SE-9061 Transistor, Power | 40-7723 |
| Q6, Q10 | 2N4248 Transistor, Signal | 40-2N4248 |
| Q7, 8 | 2N2925 Transistor, Signal | 40-4233-5 |
| Q9 | 2N3740 Transistor, Power | 40-7845 |
| Q12, 13 | 40327 Transistor, Power | 40-40327 |
| D1, 2, 3, 4, 5, 6, 7, 8 | EM401 Diode Rectifier | 40-7787-1 |
| D9 | IN5061 Diode Rectifier, High Voltage | 40-1N5061 |
| Z1 | 6.5V Diode, Zener | 40-SV6R5 |
| Z2 | IN2166A 9.4V ± 1% Diode, Zener (Factory Selected) | 40-7145-1 |
| C1 | 10 μfd @20VDC Capacitor | 56-10221-B106J20 |
| C2 | 1 μfd @ 100VDC Capacitor | 56-10206-CYC105J1 |
| C3, 9 | 0.01 μfd @ 400VDC Capacitor | 56-10205-AYA103J4 |
| C4 | 0.22 μfd @200VDC Capacitor | 56-10206-BYB224J2 |
| C5 | 0.0015 μfd @10VDC Capacitor | 56-10215-A152JE10 |
| C6, 7 | 10,000 μfd @6VDC Capacitor | 56-10202-GW109N6 |
| C8, 10 | 750 μfd @50VDC Capacitor | 56-10202-FT757N50 |
| C11 | 100 μfd @25VDC Capacitor | 56-10203-CW107N25 |
| C12 | 10 μfd @250VDC Capacitor | 56-10201-CY106N250 |
| T1 | Transformer, Power | 42-7859 |

## SCHEMATIC FOR POWER COUNTER BOARD
## MODEL 251

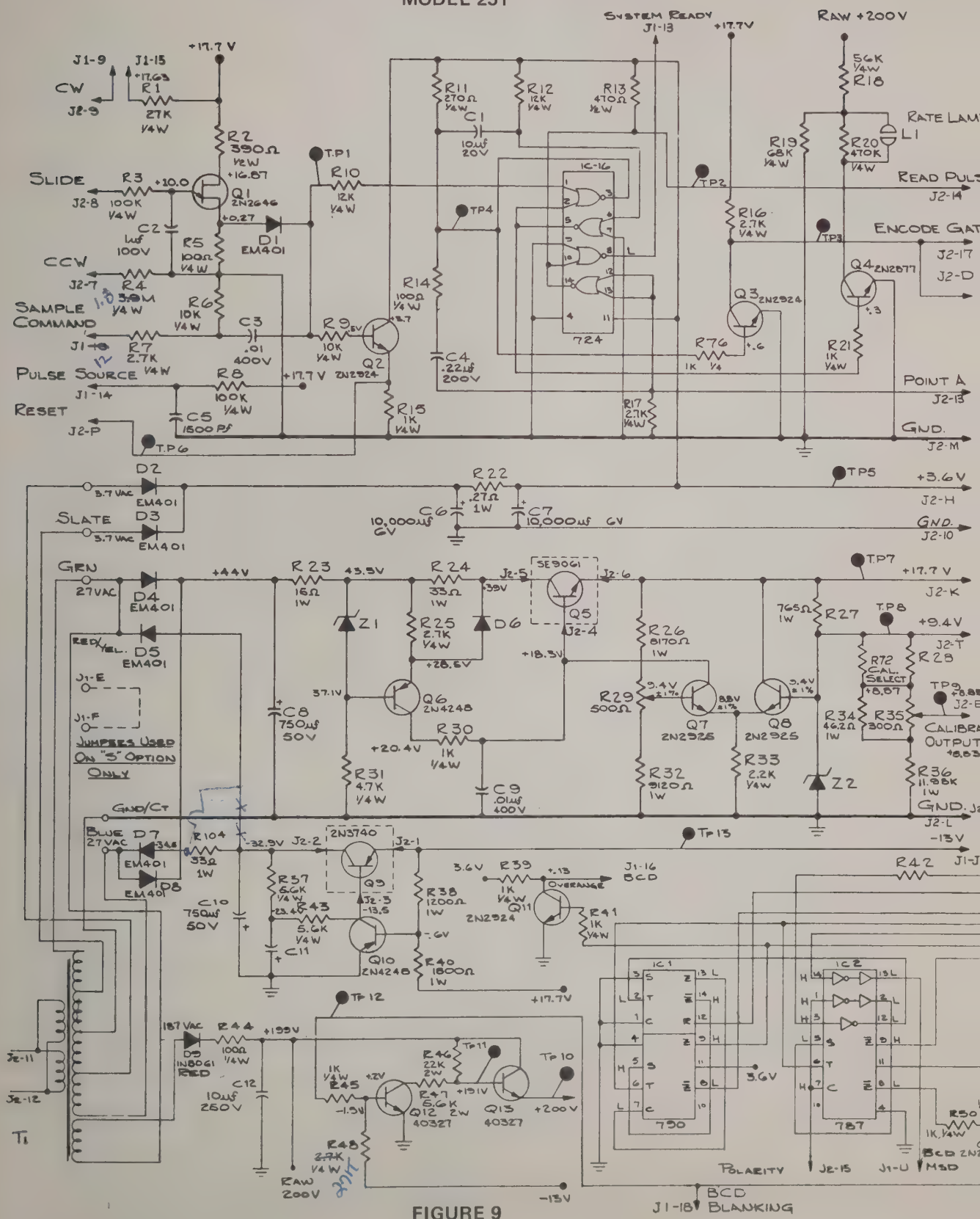
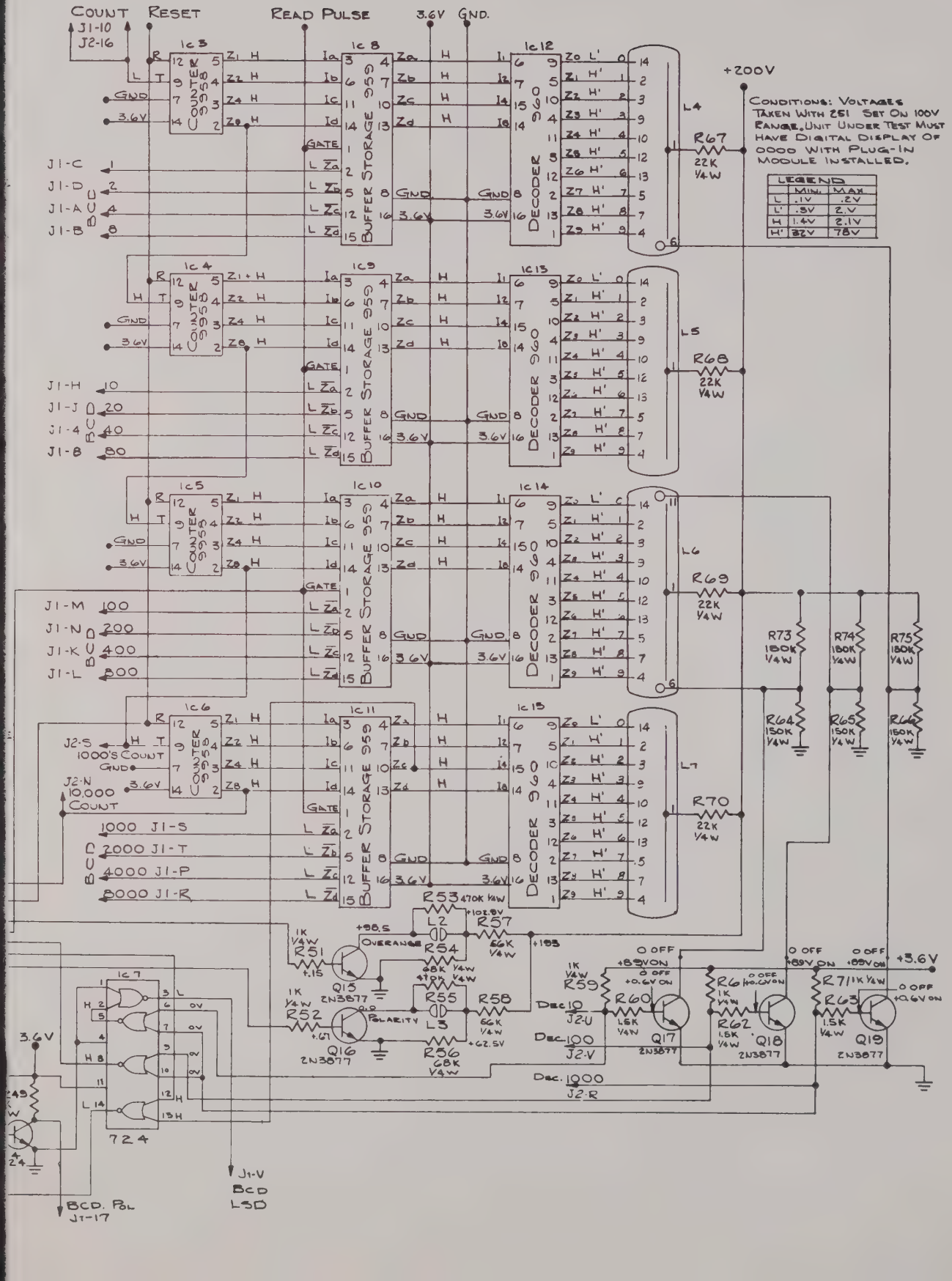



FIGURE 9


COUNT RESET
J1-10
J2-16
READ PULSE
3.6V GND.
IC3
IC8
IC12
COUNTER 9958
BUFFER STORAGE 959
DECODER 960
GND
3.6V
GATE
J1-C 1
J1-D 2
J1-A 4
J1-B 8
BCD
IC4
IC9
IC13
J1-H 10
J1-J 20
J1-4 40
J1-8 80
IC5
IC10
IC14
J1-M 100
J1-N 200
J1-K 400
J1-L 800
IC6
IC11
IC15
J2-S 1000's Count
J2-N 10,000 Count
1000 J1-S
2000 J1-T
4000 J1-P
8000 J1-R
L4
L5
L6
L7
+200V
R67 22K 1/4W
R68 22K 1/4W
R69 22K 1/4W
R70 22K 1/4W
R73 180K 1/4W
R74 180K 1/4W
R75 180K 1/4W
R64 150K 1/4W
R65 150K 1/4W
R66 150K 1/4W
CONDITIONS: VOLTAGES TAKEN WITH 251 SET ON 100V RANGE. UNIT UNDER TEST MUST HAVE DIGITAL DISPLAY OF 0000 WITH PLUG-IN MODULE INSTALLED.
LEGEND
L .1V .2V
L' .3V 2.V
H 1.4V 2.1V
H' 32V 78V
R53 470K 1/4W
L2
R57 66K 1/4W
+102.8V
+98.5
+.15
+.67
+62.5V
R51 1K 1/4W
R52 1K 1/4W
R54 68K 1/4W
R55 68K 1/4W
R58 66K 1/4W
R56 68K 1/4W
Q15 2N3877
Q16 2N3877
OVERRANGE
POLARITY
L3
R59 1K 1/4W
R60 1.5K 1/4W
R62 1.5K 1/4W
R63 1.5K 1/4W
R61 1K 1/4W
Q17 2N3877
Q18 2N3877
Q19 2N3877
0 OFF +89V ON
0 OFF +0.6V ON
Dec. 10 J2-U
Dec. 100 J2-V
Dec. 1000 J2-R
+3.6V
IC7
7 2 4
3.6V
249
Z4
J1-V BCD LSD
BCD. P&L J1-17

## PARTS LIST FOR POWER COUNTER BOARD
## MODEL 252

| SYMBOL | DESCRIPTION | STOCK NUMBER |
|---|---|---|
| R1, 48 | 27K, 10%, 1/4W, Carbon Resistor | 55-10101J27K |
| R2 | 390 Ohm, 10%, 1/2W, Carbon Resistor | 55-10102J390 |
| R3, 8 | 100K, 10%, 1/4W, Carbon Resistor | 55-10101J100K |
| R4 | ~~3.9~~Meg, 10%, 1/4W, Carbon Resistor | 55-10101J~~3R9M~~ |
| R5, 14, 44 | 100 Ohm, 10%, 1/4W, Carbon Resistor | 55-10101J100 |
| R6, 9 | 10K, 10%, 1/4W, Carbon Resistor | 55-10101J10K |
| R7, 16, 17, 25 | 2.7K, 10%, 1/4W, Carbon Resistor | 55-10101J2R7K |
| R10 | 12K, 10%, 1/4W, Carbon Resistor | 55-10101J12K |
| R11 | 270 Ohm, 10%, 1/4W, Carbon Resistor | 55-10101J270 |
| R12 | 4.7K, 10%, 1/4W, Carbon Resistor | 55-101014R7K |
| R13 | 470 Ohm, 10%, 1/2W, Carbon Resistor | 55-101012J470 |
| R15, 21, 30, 45, 49, 50, 52, 59, 61, 71, 76, 78, 79, | 1K 10%, 1/4W, Carbon Resistor | 55-10101J1K |
| R18, 58 | 56K, 10%, 1/4W, Carbon Resistor | 55-10101J56K |
| R19, 56 | 68K, 10%, 1/4W, Carbon Resistor | 55-10101J68K |
| R20, 55 | 470K, 10%, 1/4W, Carbon Resistor | 55-10101J470K |
| R22 | 0.27 Ohm, 10%, 1W, Wire Wound Resistor | 55-10124JR27 |
| R23 | 15 Ohm, 10%, 1W, Wire Wound Resistor | 55-10124J15 |
| R24, 104 | 33 Ohm, 10%, 1W, Wire Wound Resistor | 55-10124J33 |
| R26 | 8170 Ohm, 1%, 1W, Wire Wound Resistor | 55-10121ED8170 |
| R27 | 765 Ohm, 1%, 1W, Wire Wound Resistor | 55-10121ED765 |
| R28 | 18.756K, 0.1%, 1W, Wire Wound Resistor | 55-10121BD18R756K |
| R29 | 500 Ohm, 20%, 2W, Trimmer BE-36124 | 55-10151K500 |
| R31 | 4.7K, 10%, 1/4W, Carbon Resistor | 55-10101J4R7K |
| R32 | 9120 Ohm, 1%, 1W, Wire Wound Resistor | 55-10121ED9120 |
| R33 | 2.2K, 10%, 1/4W, Carbon Resistor | 55-10101J2R2K |
| R34 | 100 Ohm, 1%, 1W, Wire Wound Resistor | 55-10121ED100 |
| R35 | 300 Ohm, 20%, 2W, Trimmer BE-36123 | 55-10151K300 |
| R36 | 7350 Ohm, 0.5%, 1W, Wire Wound Resistor | 55-10121DD7350 |
| R37, 43 | 5.6K, 10%, 1/4W, Carbon Resistor | 55-10101J5R6K |
| R38 | 1200 Ohm, 1%, 1W, Wire Wound Resistor | 55-10121ED1200 |
| R40 | 1800 Ohm, 1%, 1W, Wire Wound Resistor | 55-10121ED1800 |
| R46 | 22K, 10%, 2W, Carbon Resistor | 55-10104J22K |
| R47 | 5.6K, 10%, 2W, Carbon Resistor | 55-10104J5R6K |
| R60, 62, 63, 77, 87 | 1.5K, 10%, 1/4W, Carbon Resistor | 55-10101J1R5K |
| R64, 65, 66, 102 | 150K, 10%, 1/4W, Carbon Resistor | 55-10101J150K |
| R67, 68, 69, 70 | 18K, 10%, 1/4W, Carbon Resistor | 55-10101J18K |
| R72 | Factory Selected | |
| R73, 74, 75, 82 83, 84, 103 | 180K, 10%, 1/4W, Carbon Resistor | 55-10101J180K |
| R80, 81 | 6.8K, 10%, 1/4W. Carbon Resistor | 55-10101J6R8K |
| R86 | 6.8K, 10%, 1/4W, Carbon Resistor | 55-10101J6R8K |
| R85 | 680K, 10%, 1/4W, Carbon Resistor | 55-10101J680K |
| R88, 110 | 680, 10%, 1/4W, Carbon Resistor | 55-10101J680 |

FIGURE 10

## PARTS LIST FOR POWER COUNTER BOARD
## MODEL 252 (Cont.)

| SYMBOL | DESCRIPTION | STOCK NUMBER |
|---|---|---|
| L1, 3 | Lamp, Neon A245 | 52-7654 |
| L4, 6 | Nixie Tube B5441 | 49-6921-2 |
| L5, 7 | Nixie Tube B5440 | 49-6921-1 |
| Power Supply & Counter Circuit Board | | 54-7549 |
| Mother Board | | 54-7280 |
| SW-1 | On-Off Switch and Rate Control | GC-45-4 |
| IC18, 19 | Dual J-K Flip-Flop MC790P | 40-7485 |
| IC3, 4, 5 | Counter 958 | 40-7516 |
| IC16, 20, 21 | Quad and Gate MC724P | 40-7483 |
| IC8, 9, 10 | Buffer Storage 959 | 40-7514 |
| IC12, 13, 14 | Decoder 960 | 40-7510 |
| IC17 | Single J-K Flip Flop MC723 | |
| Q1 | 2N2646 Unijunction Transistor | 40-7794 |
| Q2, 3, 14, 100, 25 | 2N2924 Transistor, Signal | 40-4233-4 |
| Q4, 16, 17, 18 19, 21, 22, 23 24 | 2N3877 Transistor, Signal | 40-2N3877 |
| Q5 | SE9061 Transistor, Power | 40-7723 |
| Q6, 10 | 2N4248 Transistor, Signal | 40-2N4248 |
| Q7, 8 | 2N2925 Transistor, Signal | 40-4233-5 |
| Q9 | 2N3740 Transistor, Power | 40-7845 |
| Q12, 13 | 40327 Transistor, Power | 40-40327 |
| D1, 2, 3, 4, 5, 6, 7, 8 | EM401 Diode Rectifier | 40-7787-1 |
| D9 | IN5061 Diode Rectifier, High Voltage | 40-1N5061 |
| Z1 | 6.5V Diode, Zener | 40-SV6R5 |
| Z2 | 1N2166A, 9.4V ±1%, Diode, Zener (Factory Selected) | 40-7145-2 |
| C1 | 10 μfd @20VDC Capacitor | 56-10221-B106J20 |
| C2 | 1 μfd @ 100VDC Capacitor | 56-10206-CYC105J1 |
| C3, 9 | 0.01 μfd @ 400VDC Capacitor | 56-10205-AYA103J4 |
| C4 | 0.22 μfd @ 200VDC Capacitor | 56-10206-BYB224J2 |
| C5 | 0.0015 μfd @ 10VDC Capacitor | 56-10215-A152JE10 |
| C6, 7 | 10,000 μfd @ 6VDC Capacitor | 56-10202-GW109N6 |
| C8, 10 | 750 μfd @ 50VDC Capacitor | 56-10202-FT757N50 |
| C11 | 100 μfd @ 25VDC Capacitor | 56-10203-CW107N25 |
| C12 | 10 μfd @ 250VDC Capacitor | 56-10201-CY106N250 |
| T1 | Transformer, Power | 42-7859 |

# SCHEMATIC FOR POWER COUNTER BOARD
## MODEL 252

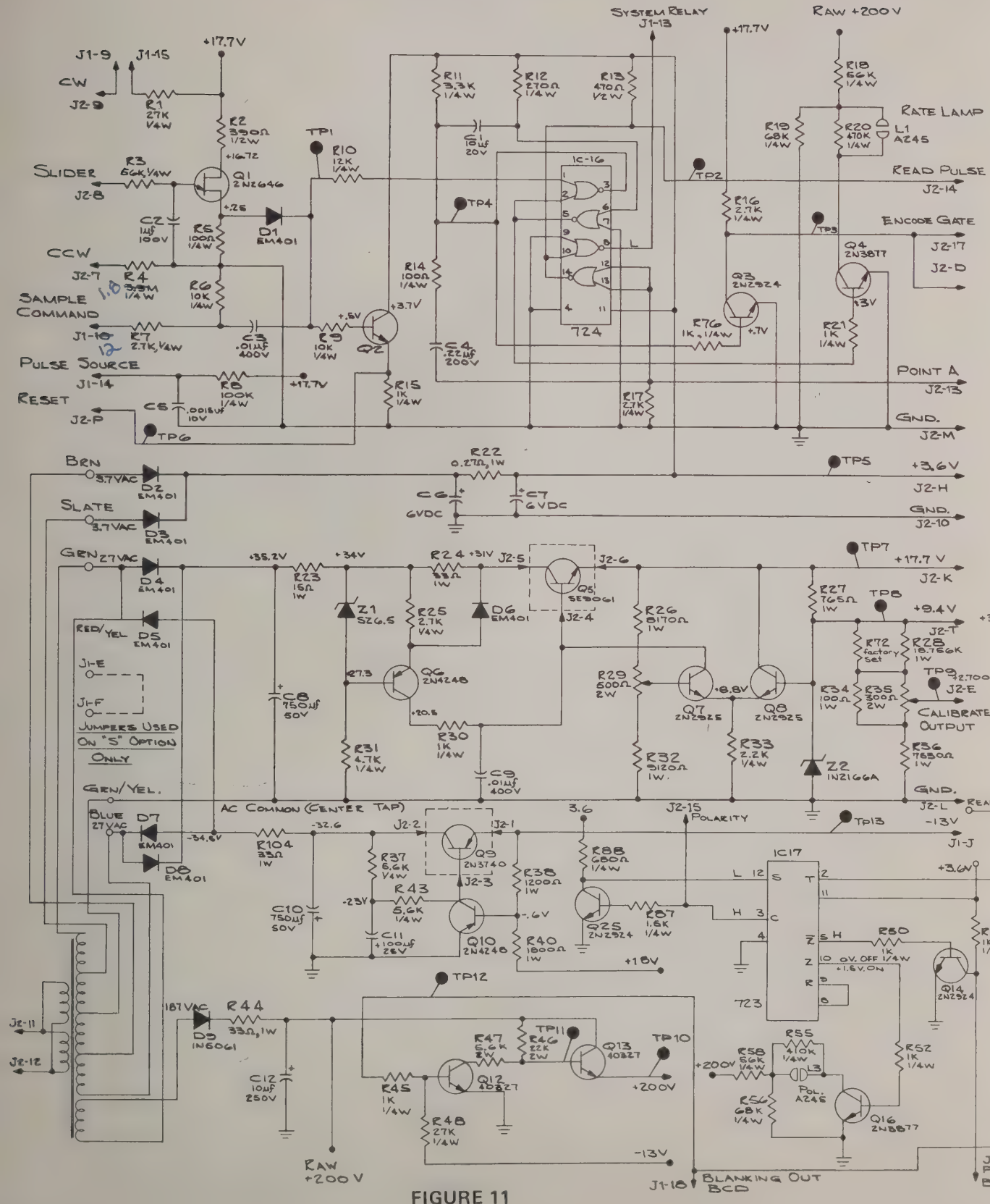
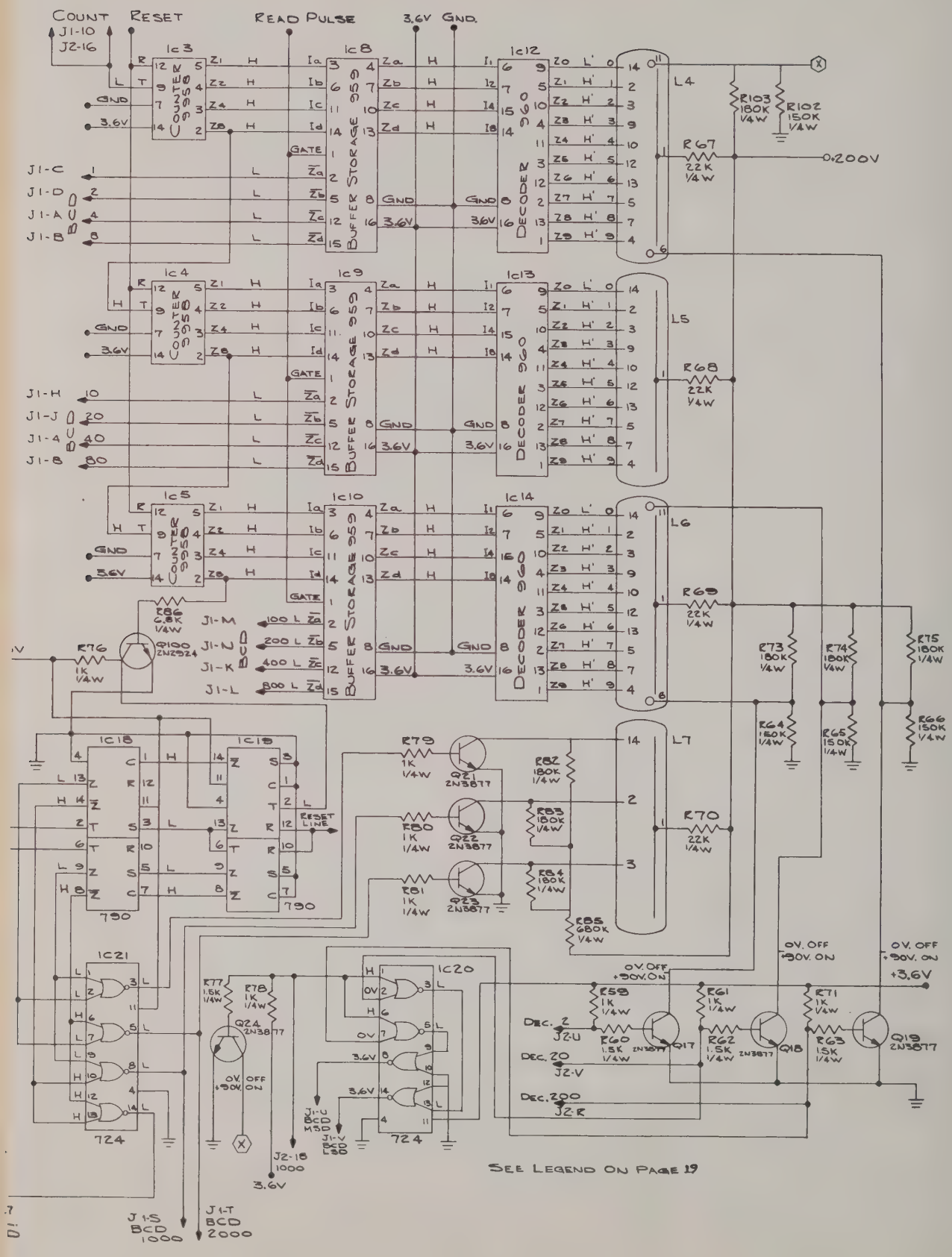


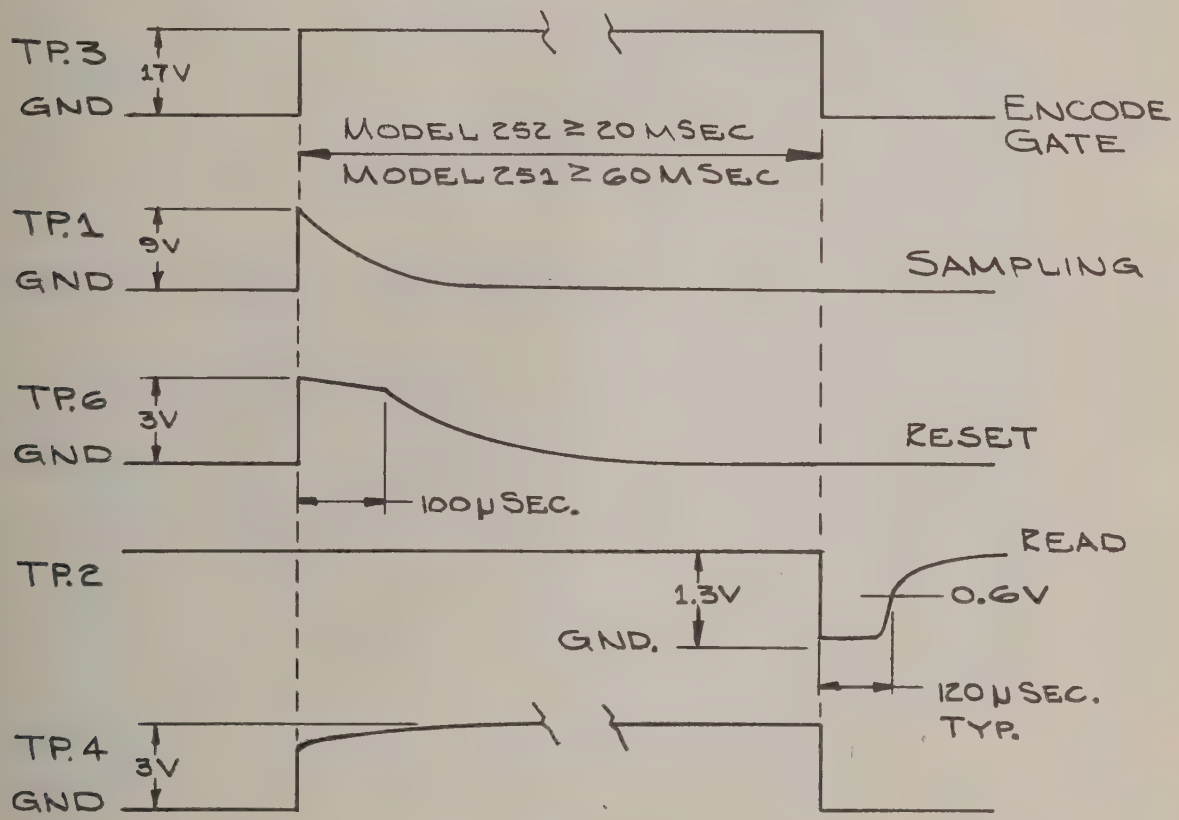

FIGURE 11




SEE LEGEND ON PAGE 19

## WAVE SHAPES & VOLTAGE SPECIFICATIONS

THE OSCILLOSCOPE IS TO BE TRIGGERED ON THE ON POSITIVE SLOPE OF THE ENCODE GATE.




TP5 — NOMINALLY +3.6V
TP7 — +17.7 V ±1%
TP8 — +9.4V ±1%
TP9 — CALIBRATE VOLTAGE ±.01%
TP10 — NOMINALLY +200V
TP11 — +191 V
TP12 — UNBLANKED CONDITION = +0.5V
BLANKED CONDITION > +1.5 V

FIGURE 12

VOLTAGE AND READINGS ON 251 POWER SUPPLY
COUNTER BOARD
CONDITIONS: VOLTAGES TAKEN WITH 251 SET ON
100 V RANGE, UNIT UNDER TEST MUST HAVE A DIGITAL
DISPLAY OF 0000 WITH PLUG-IN MODULE INSTALLED
LEGEND
MIN. MAX.
L .1V .2V
L' .5V 2.5V
H 1.4V 2.1V
H' 32V 78V
U1 790
U2 787
U3 724
U4 958
U5 958
U6 958
U7 958
U8 959
U9 959
U10 959
U11 959
U12 960
U13 960
U14 960
U15 960
U16 724

FIGURE 13

# VOLTAGE READING ON 252 POWER SUPPLY/COUNTER BOARD

CONDITIONS: VOLTAGES TAKEN WITH 252 SET ON 200V RANGE, UNIT UNDER TEST MUST HAVE A DIGITAL DISPLAY OF 0000 WITH PLUG-IN MODUAL INSTALLED.

| LEGEND | | |
|---|---|---|
| | MIN. | MAX. |
| L | .1V | .2V |
| L' | .5V | 2.V |
| H | 1.4V | 2.1V |
| H' | 32V | 78V |

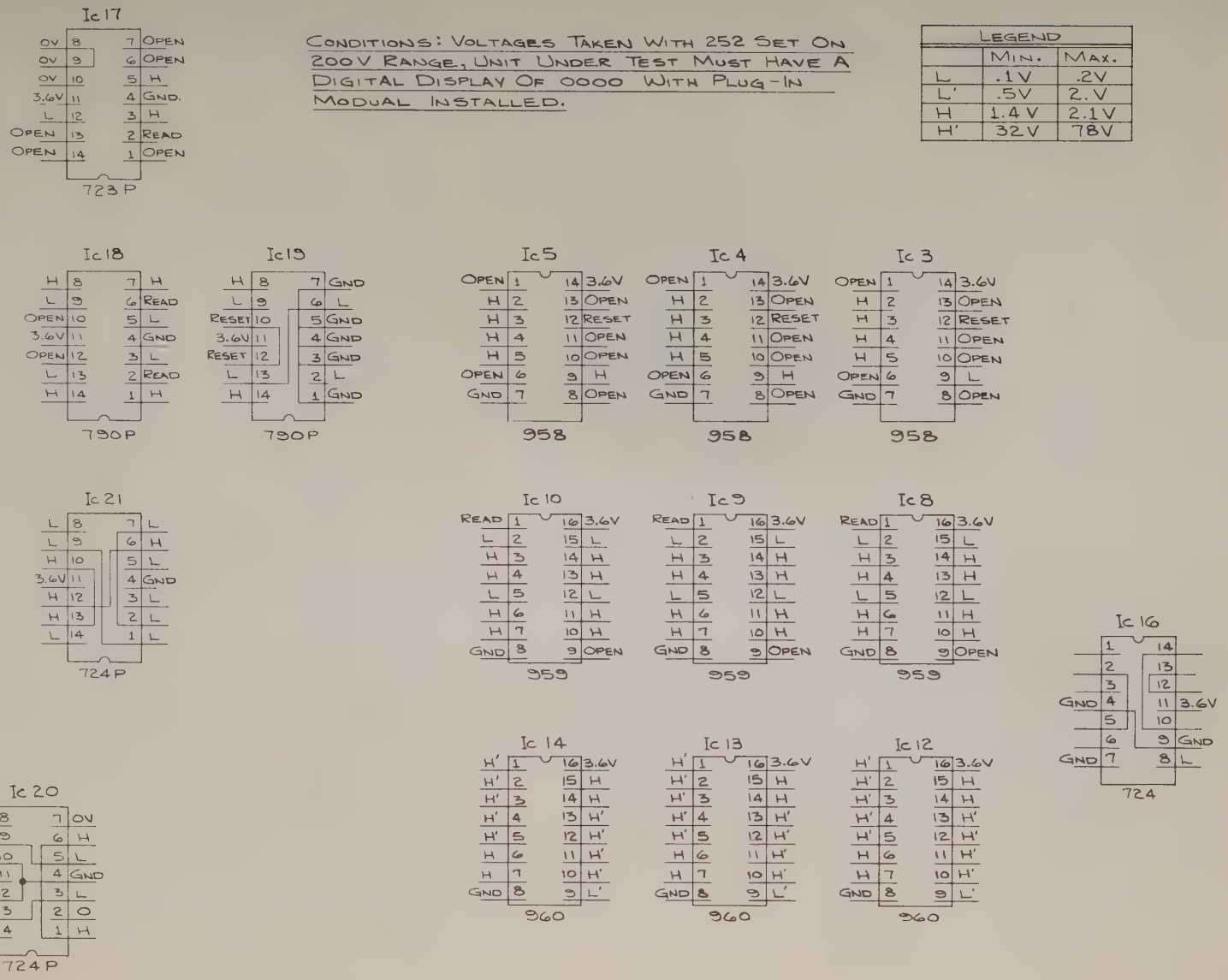
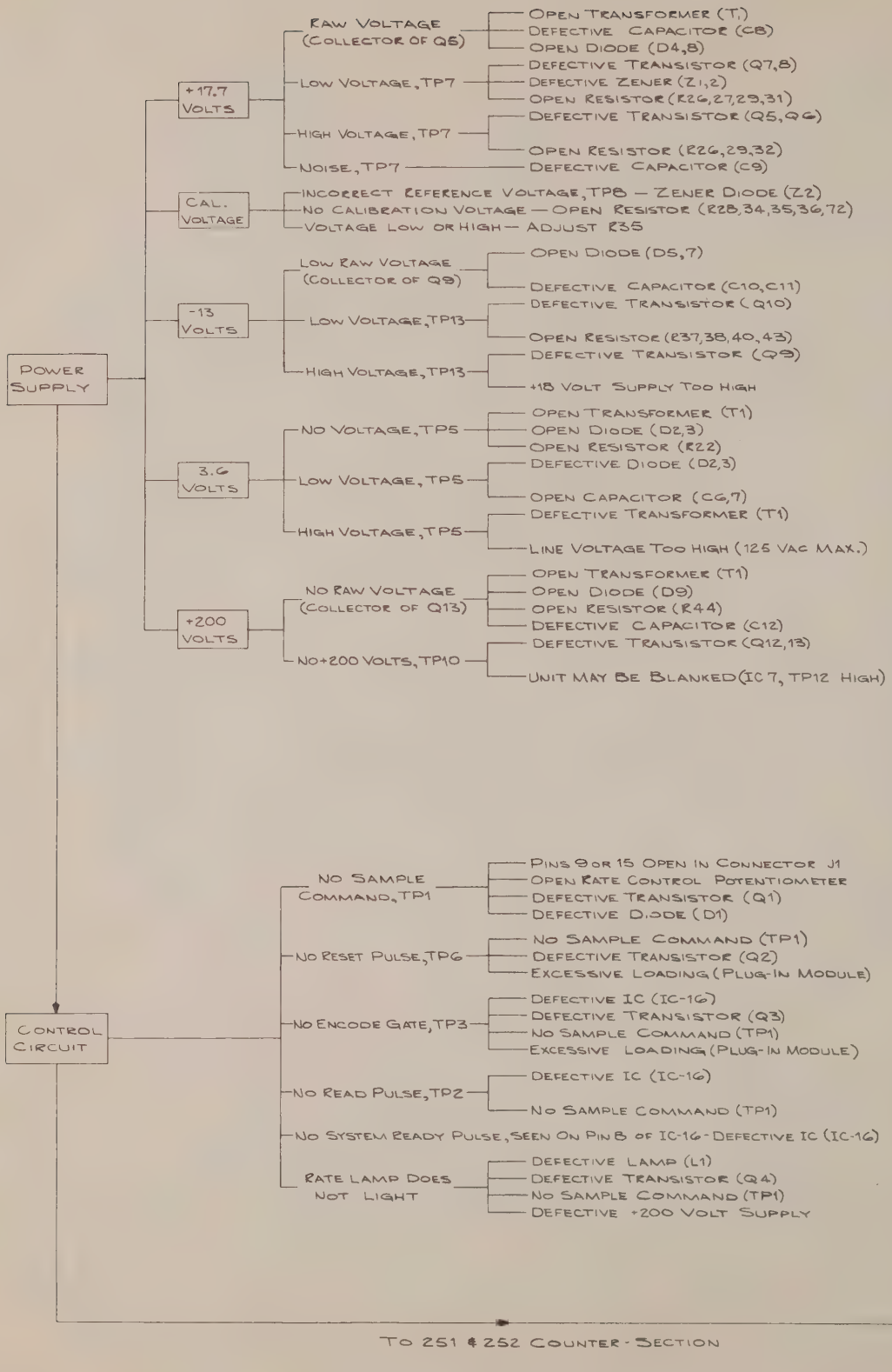
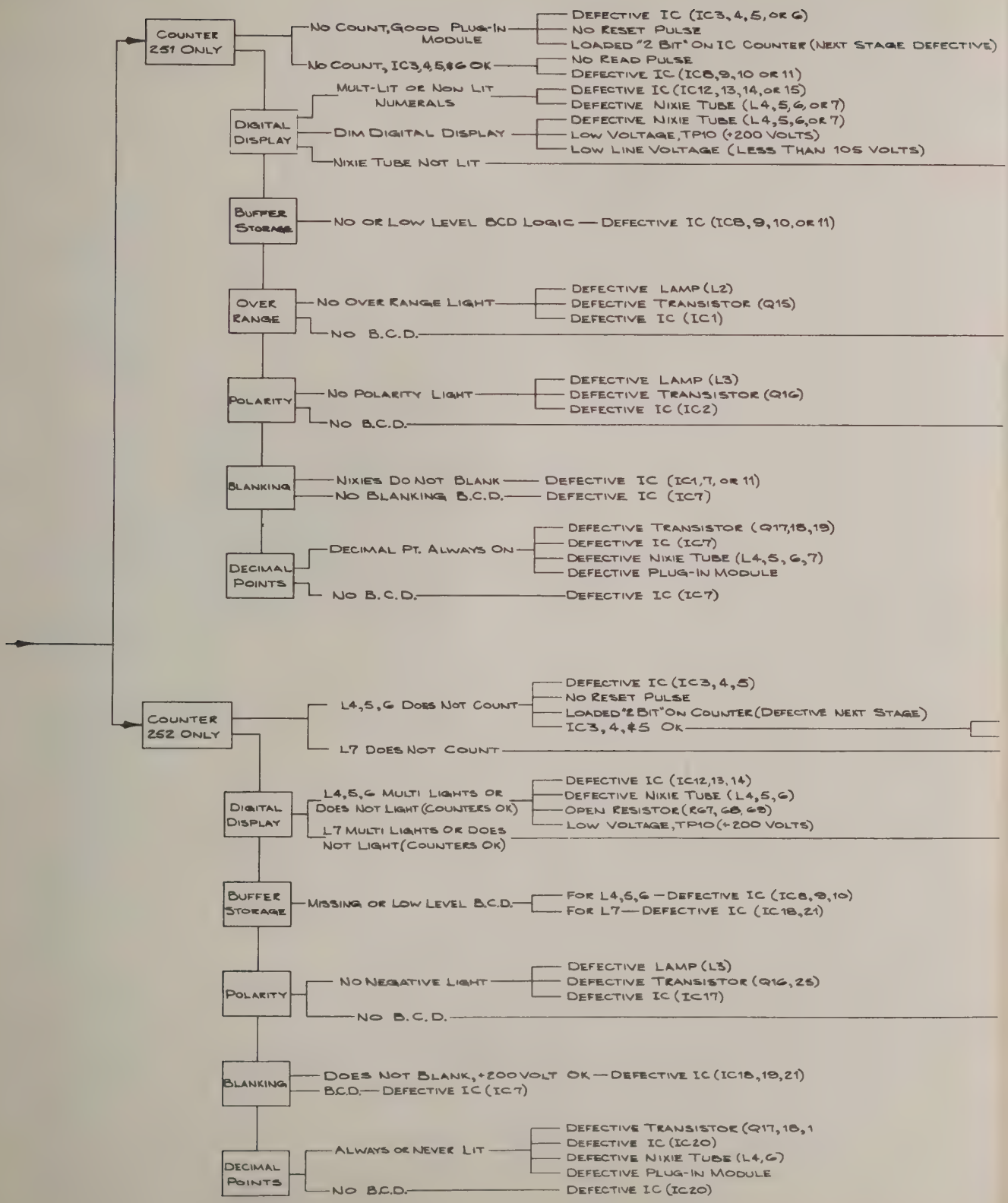
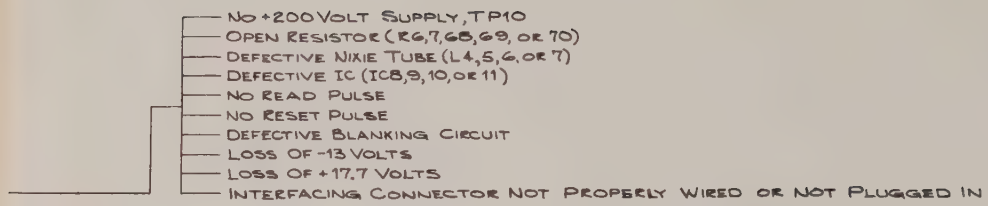


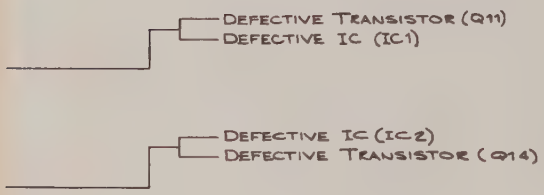

FIGURE 14

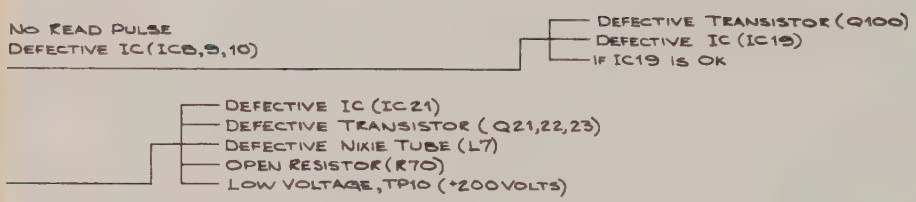

POWER SUPPLY
+17.7 VOLTS
RAW VOLTAGE (COLLECTOR OF Q5)
OPEN TRANSFORMER (T1)
DEFECTIVE CAPACITOR (C8)
OPEN DIODE (D4,8)
LOW VOLTAGE, TP7
DEFECTIVE TRANSISTOR (Q7,8)
DEFECTIVE ZENER (Z1,2)
OPEN RESISTOR (R26,27,29,31)
HIGH VOLTAGE, TP7
DEFECTIVE TRANSISTOR (Q5,96)
OPEN RESISTOR (R26,29,32)
NOISE, TP7
DEFECTIVE CAPACITOR (C9)
CAL. VOLTAGE
INCORRECT REFERENCE VOLTAGE, TP8 — ZENER DIODE (Z2)
NO CALIBRATION VOLTAGE — OPEN RESISTOR (R28,34,35,36,72)
VOLTAGE LOW OR HIGH — ADJUST R35
-13 VOLTS
LOW RAW VOLTAGE (COLLECTOR OF Q9)
OPEN DIODE (D5,7)
DEFECTIVE CAPACITOR (C10,C11)
LOW VOLTAGE, TP13
DEFECTIVE TRANSISTOR (Q10)
OPEN RESISTOR (R37,38,40,43)
HIGH VOLTAGE, TP13
DEFECTIVE TRANSISTOR (Q9)
+18 VOLT SUPPLY TOO HIGH
3.6 VOLTS
NO VOLTAGE, TP5
OPEN TRANSFORMER (T1)
OPEN DIODE (D2,3)
OPEN RESISTOR (R22)
LOW VOLTAGE, TP5
DEFECTIVE DIODE (D2,3)
OPEN CAPACITOR (C6,7)
HIGH VOLTAGE, TP5
DEFECTIVE TRANSFORMER (T1)
LINE VOLTAGE TOO HIGH (125 VAC MAX.)
+200 VOLTS
NO RAW VOLTAGE (COLLECTOR OF Q13)
OPEN TRANSFORMER (T1)
OPEN DIODE (D9)
OPEN RESISTOR (R44)
DEFECTIVE CAPACITOR (C12)
NO +200 VOLTS, TP10
DEFECTIVE TRANSISTOR (Q12,13)
UNIT MAY BE BLANKED (IC 7, TP12 HIGH)
CONTROL CIRCUIT
NO SAMPLE COMMAND, TP1
PINS 9 OR 15 OPEN IN CONNECTOR J1
OPEN RATE CONTROL POTENTIOMETER
DEFECTIVE TRANSISTOR (Q1)
DEFECTIVE DIODE (D1)
NO RESET PULSE, TP6
NO SAMPLE COMMAND (TP1)
DEFECTIVE TRANSISTOR (Q2)
EXCESSIVE LOADING (PLUG-IN MODULE)
NO ENCODE GATE, TP3
DEFECTIVE IC (IC-16)
DEFECTIVE TRANSISTOR (Q3)
NO SAMPLE COMMAND (TP1)
EXCESSIVE LOADING (PLUG-IN MODULE)
NO READ PULSE, TP2
DEFECTIVE IC (IC-16)
NO SAMPLE COMMAND (TP1)
NO SYSTEM READY PULSE, SEEN ON PIN 8 OF IC-16 - DEFECTIVE IC (IC-16)
RATE LAMP DOES NOT LIGHT
DEFECTIVE LAMP (L1)
DEFECTIVE TRANSISTOR (Q4)
NO SAMPLE COMMAND (TP1)
DEFECTIVE +200 VOLT SUPPLY
TO 251 & 252 COUNTER-SECTION

FIGURE


COUNTER 251 ONLY
NO COUNT, GOOD PLUG-IN MODULE
DEFECTIVE IC (IC3, 4, 5, OR 6)
NO RESET PULSE
LOADED "2 BIT" ON IC COUNTER (NEXT STAGE DEFECTIVE)
NO COUNT, IC3, 4, 5, & 6 OK
NO READ PULSE
DEFECTIVE IC (IC8, 9, 10 OR 11)
DIGITAL DISPLAY
MULT-LIT OR NON LIT NUMERALS
DEFECTIVE IC (IC12, 13, 14, OR 15)
DEFECTIVE NIXIE TUBE (L4, 5, 6, OR 7)
DIM DIGITAL DISPLAY
DEFECTIVE NIXIE TUBE (L4, 5, 6, OR 7)
LOW VOLTAGE, TP10 (+200 VOLTS)
LOW LINE VOLTAGE (LESS THAN 105 VOLTS)
NIXIE TUBE NOT LIT
BUFFER STORAGE
NO OR LOW LEVEL BCD LOGIC — DEFECTIVE IC (IC8, 9, 10, OR 11)
OVER RANGE
NO OVER RANGE LIGHT
DEFECTIVE LAMP (L2)
DEFECTIVE TRANSISTOR (Q15)
DEFECTIVE IC (IC1)
NO B.C.D.
POLARITY
NO POLARITY LIGHT
DEFECTIVE LAMP (L3)
DEFECTIVE TRANSISTOR (Q16)
DEFECTIVE IC (IC2)
NO B.C.D.
BLANKING
NIXIES DO NOT BLANK — DEFECTIVE IC (IC1, 7, OR 11)
NO BLANKING B.C.D. — DEFECTIVE IC (IC7)
DECIMAL POINTS
DECIMAL PT. ALWAYS ON
DEFECTIVE TRANSISTOR (Q17, 18, 19)
DEFECTIVE IC (IC7)
DEFECTIVE NIXIE TUBE (L4, 5, 6, 7)
DEFECTIVE PLUG-IN MODULE
NO B.C.D. — DEFECTIVE IC (IC7)
COUNTER 252 ONLY
L4, 5, 6 DOES NOT COUNT
DEFECTIVE IC (IC3, 4, 5)
NO RESET PULSE
LOADED "2 BIT" ON COUNTER (DEFECTIVE NEXT STAGE)
IC3, 4, & 5 OK
L7 DOES NOT COUNT
DIGITAL DISPLAY
L4, 5, 6 MULTI LIGHTS OR DOES NOT LIGHT (COUNTERS OK)
DEFECTIVE IC (IC12, 13, 14)
DEFECTIVE NIXIE TUBE (L4, 5, 6)
OPEN RESISTOR (R67, 68, 69)
LOW VOLTAGE, TP10 (+200 VOLTS)
L7 MULTI LIGHTS OR DOES NOT LIGHT (COUNTERS OK)
BUFFER STORAGE
MISSING OR LOW LEVEL B.C.D.
FOR L4, 5, 6 — DEFECTIVE IC (IC8, 9, 10)
FOR L7 — DEFECTIVE IC (IC18, 21)
POLARITY
NO NEGATIVE LIGHT
DEFECTIVE LAMP (L3)
DEFECTIVE TRANSISTOR (Q16, 25)
DEFECTIVE IC (IC17)
NO B.C.D.
BLANKING
DOES NOT BLANK, +200 VOLT OK — DEFECTIVE IC (IC18, 19, 21)
B.C.D. — DEFECTIVE IC (IC7)
DECIMAL POINTS
ALWAYS OR NEVER LIT
DEFECTIVE TRANSISTOR (Q17, 18, 1
DEFECTIVE IC (IC20)
DEFECTIVE NIXIE TUBE (L4, 6)
DEFECTIVE PLUG-IN MODULE
NO B.C.D.
DEFECTIVE IC (IC20)


No +200 Volt Supply, TP10
Open Resistor (R6,7,68,69, or 70)
Defective Nixie Tube (L4,5,6, or 7)
Defective IC (IC8,9,10, or 11)
No Read Pulse
No Reset Pulse
Defective Blanking Circuit
Loss of -13 Volts
Loss of +17.7 Volts
Interfacing Connector Not Properly Wired or Not Plugged In


Defective Transistor (Q11)
Defective IC (IC1)
Defective IC (IC2)
Defective Transistor (Q14)


No Read Pulse
Defective IC (IC8,9,10)
Defective Transistor (Q100)
Defective IC (IC19)
If IC19 is OK
Defective IC (IC21)
Defective Transistor (Q21,22,23)
Defective Nixie Tube (L7)
Open Resistor (R70)
Low Voltage, TP10 (+200 Volts)

Defective Transistor (Q14,26)
Defective IC (IC17)

# Notes

# Notes

MP MASTER
MA26224